CLIMATE-FRIENDLY CITIES

A Handbook on the Tasks and Possibilities of European Cities in Relation to Climate Change

2011.hu

Hungarian Presidency of the Council of the European Union

MINISTRY OF INTERIOR

CLIMATE-FRIENDLY CITIES
A Handbook on the Tasks and Possibilities of European Cities in Relation to Climate Change

Issued within the framework of the Hungarian Presidency of the Council of the European Union

Budapest, 2011

Please cite this publication as:

Ministry of Interior, Hungary – VÁTI Hungarian Nonprofit Ltd. for Regional Development and Town Planning (2011), Climate-Friendly Cities – A Handbook on the Tasks and Possibilities of European Cities in Relation to Climate Change, Ministry of Interior, Hungary – VÁTI, Budapest

ISBN 978-963-7380-24-2

This publication was prepared upon the commission and with the support of the *Ministry of Interior, Hungary*

Deputy State Secretary: *Dr. Péter Szaló*
Head of Department: *Dr. Géza Tompai*
Chief coordinator: *Dr. Andrea Iván*

VÁTI Hungarian Non-profit Ltd. for Regional Development and Town Planning (VÁTI)
General director: *Dr. Zoltán Vereczkey*
Director: *Nándor Horkay*

Partner institute: *Metropolitan Research Institute Ltd. Budapest*

Edited by: *Salamin, Géza; Kohán, Zoltán; Dobozi, Eszter; Péti, Márton*

Written by:
Antal, Z. László (Institute of Sociology of the HAS) 9., 10.
Czira, Tamás (VÁTI) 6.
Dobozi, Eszter (VÁTI) 1., 5.
Ekés, András (Metropolitan Research Institute Ltd.) 5., 11., 13.
Ertsey, Attila (KÖR Architect Studio Co. Ltd.) 7.
Gerőházi, Éva (Metropolitan Research Institute Ltd.) 11., 13.
Ginter, Gábor (VÁTI) 7.3.4.
Györe, Ágnes (VÁTI) 12.3.
Kohán, Zoltán (VÁTI) 1.2.3., 1.2.4., 8., 12.1., 12.2.
Lajtai, Ádám (VÁTI) 11.4.
Leidinger, Dániel (Institute of Sociology of the HAS) 9., 10.
Péti, Márton (VÁTI) 2., 3., 12.
Rideg, Adrienn (VÁTI) Appendix
Salamin, Géza (VÁTI) Introduction, 4.
Selmeczi, Pál (VÁTI) 6.
Somfai, Ágnes (VÁTI) 4.5, 4.6.
Somogyi, Eszter (Metropolitan Research Institute Ltd.) 11., 13.

Contributing authors: *Antal, Z. László (2., 9); Brodorits, Zoltán (good practices); Czakó, Veronika (1., 6., proof reading); Cserni, Tímea (4.); Györe, Ágnes (Appx.); Holtzman, Assaf (proof reading,); Horváth, Sára Erzsébet (7.); Keith, Thorpe (13.); Kohán, Zoltán (1., 2., 3., 5., 6., 7.); Lajtai, Ádám (8., 12., good practices); Leidinger, Dániel (2.); Madarász, Anett (Appx., good practices); Mészáros, Bence (Appx., good practices); Nagy, András (5., 9., 11, Appx.); Németh, Sarolta (2., 3., 5., 7., 8., proof reading); Pálvölgyi, Tamás (7.); Polomik, Heléna (proof reading); Prokai, Réka (2.); Ricz, Judit (4.8.).; Rideg, Adrienn (9., good practices); Sain, Mátyás (3., design); Salamin, Géza (2., 3.); Sütő, Attila (4.4.); Szabó, Balázs (2., 13., good practices); Szobi, Veronika (good practices); Tomay, Kyra (4.8.); Topa, Zoltán (good practices); Hoffmann, Csilla (good practices);*

Contributing institutes:
City of Vaxjö, Vaxjö, Sweden
Pro EcoEnergia Ltd., Bansko, Bulgaria
EOS Group, Ostend, Belgium
Greve Municipality, Greve, Denmark
City of Copenhagen, Technical and Environmental, Parks and Nature, Copenhagen, Denmark
An Taisce, Ireland
City of Stockholm / Glashus Ett, Stockholm, Sweden
Madrid City Council, Madrid, Spain
Trondheim Municipality, Trondheim, Norway
City of Tampere, Tampere, Finland
Riudecanyes City Council, Riudecanyes, Spain
City Council of Valladolid, Valladolid, Spain
The Norwegian Association of Local and Regional Authorities, Norway
Ministry of Transport, Construction and Regional Development, Slovakia
Terres en Ville, France
KÖR Architect Studio Co. Ltd.
Association of Climate-Friendly Settlements, Hungary
Institute of Sociology of the Hungarian Academy of Sciences, Research Group for Climate Change
Other contributing institutes in Appendix IV.

Printed by *IAMART Design Kft., Hungary*

TABLE OF CONTENTS

Climate-friendly cities for a healthy and wealthy European Union

With the Europe 2020 strategy, the European Union has set itself the ambitious goal of recovering our economies and tackling future challenges at the same time. Growth in Europe needs to become smarter, socially more inclusive and – after all – more sustainable.

Making the strategy a success will require efforts and contributions from all levels of government, the private sector and NGOs. Undoubtedly, cities will have to play a crucial role in delivering our common priorities. Indeed, there are two good reasons why we need to create solid links between cities and Europe 2020: Firstly, because they have a unique potential for green, smart and socially inclusive growth. They are a key location for economic progress and innovation. It is in the cities, where we need to solve challenges related to social exclusion and poverty. And it is also in urban areas, where a great potential for energy saving lies. We also need the driving power of our cities for smart economic growth. The second reason is of course, that the necessary investment will require massive financial means. Cohesion policy can be one instrument to help our local authorities in their efforts. Implementing new energy schemes, creating new jobs and businesses or fostering social innovation at local level will remain priority topics on Europe's political agenda.

Ideally, this process is managed in an integrated manner. The question of climate change clearly underlines the need for such a holistic, well-coordinated approach. Creating synergies between economic development, social questions and environmental sustainability is crucial. It is probably in our cities where this triangle becomes most visible. Green businesses and eco-innovation can create new employment opportunities and reduce $C0_2$-emissions at the same time. Investment in eco-efficient urban infrastructures enables these businesses to flourish and bring more people into the labour market. And higher levels of employment will finally help to overcome income-related, negative energy consumption patterns and to generate the necessary financial resources to incentivise new, climate-proof ways of growth.

The maybe most remarkable feature of cities is that they are both, a major challenge and a key solution to climate change. According to world-wide estimations, cities use about two thirds of the final energy demand and generate up to 70% of all $C0_2$ emissions. To reduce these shares is indeed a challenge. However, thanks to their high density structure, cities also have the potential to work in a very energy-efficient way. This compactness which results in shorter ways has direct influence on comparatively low frequencies of car use and the functioning of clean urban transport systems. Equally, the success of resource extensive heating systems is linked to the assets of agglomeration and concentration.

Finally, cities are focal points for consumption behaviours and innovation. With over 73% of our population living in urban areas, they play a key role in promoting new consumption habits and applying green technology. As the first contact point between the citizen and the administration, activities at city-level are tangible and visible to citizens. Local empowerment is vital in this respect. In addition, networking among cities and local authorities across the Union will be essential for mutual learning and for disseminating innovative climate actions.

Given the fact that many cities neither have the power nor the financial means to implement efficient climate change plans, cohesion policy operations can indeed make a difference.

Already in the current 2007-2013 programming period, measures to combat climate change amount up to EUR 50 billion or 14% of the available budget for Cohesion Policy. Also in the future climate change actions will remain one of our top priorities. Together with our cities and regions, we will continue to invest in eco-innovation, in renewable energies and energy efficiency, in clean urban transport and in other climate-proof urban infrastructures. In all this, we need our cities to take a leading role.

Our cities are vital for making growth in Europe smart, sustainable and socially inclusive. They are our best bet in winning the race against climate change. We need our cities for a healthy and wealthy European Union.

Johannes Hahn
European Commissioner for Regional Policy

FOREWORD TO THE HANDBOOK

The issue of urban development represents a priority for the Hungarian Presidency of the Council of the European Union and special emphasis is placed on *sustainable* urban development in an age when the global challenges we face are able to significantly influence the life of every citizen of cities. For this very reason, the Hungarian Presidency wishes to contribute to the debate on European urban policy by focusing on two of the major challenges that our cities face, namely the global trends of climate change and demographic change. While urban demographic challenges have been covered by a comprehensive European evaluation report of the Hungarian Presidency, the handbook you are now holding wishes to contribute to the efforts of our European cities and towns as they combat climate change, by widening our knowledge base on this issue.

The first half of 2011 is an important period in terms of thinking about the future of the European Union as, building on the outcomes of the Fifth Cohesion Report and on the general directions identified by the EU 2020 Strategy adopted last year, the cohesion policy of the future is now being shaped. In our view, it is especially important that the greatest possible pool of relevant knowledge on cities is made available during this period in order to ensure that the urban dimension is appropriately reflected in the Cohesion Policy. At the same time, in order to successfully achieve the strategic goals of the Union, it is of fundamental importance that the various players, including the governing bodies of European cities, have the appropriate knowledge to perform their tasks, including, among other challenges, the fight against climate change.

Global changes are presenting us the challenges capable to influence the life of every human being thus mitigating the adverse processes and adapting to the impacts of the changes are our shared responsibility. This is especially true in respect of the climate change phenomenon, which, in geographically differing ways and to various extent, is capable of bringing changes and presenting new dangers to the most parts of the world. A significant part of both the fundamental causes and, even more so, the consequences of climate change are concentrated in urban areas. Even without the global climate change, the micro- and mesoclimates of towns and cities differ significantly from those of less urbanised areas, and these differences may be further reinforced by climate change.

Climate change and related urban policy responses have by now become part of the European thought, alongside with other integrated urban development issues. This is in fact reflected in a range of documents. Adopted in 2007, the **Leipzig Charter** on Sustainable European Cities underlines the need for defining integrated urban development policies with the aim of coordinating the spatial, sectorial and temporal aspects of the core areas of urban policy, while also focusing on the issue of climate change within the general context of sustainability. In order to improve the utilisation of integrated urban development policy, the Leipzig Charter offers recommendations on the creation and maintenance of high quality public space, for modernising infrastructure networks, and for increasing energy efficiency, marking the direction for climate-friendly urban development.

One of the three central thematic areas of the statement adopted by the meeting of ministers responsible for urban development which was organised during the French Presidency in 2008, in **Marseille**, explicitly urges that climate change is taken into consideration in relation to urban development. This document specifically draws attention to the possible role of cities in climate change adaptation and to the fact that investments are needed in this area. Furthermore, it calls for the exchange of knowledge and experience and the shaping of local energy, climate, and mobility policies, emphasising the role of urban planning and the importance of support for compact and sustainable cities.

The **Toledo Declaration**, adopted on 22 June, 2010 during the Spanish EU Presidency, also call special attention to integrated urban development and lays particular emphasis on the necessity of having a common interpretation of the integrated approach. In the Toledo Reference Document, in respect of the environment, the Ministers emphasised, *inter alia*, the role of metropolitan regions and cities in combating climate change.

Again, the **Europe 2020 Strategy** also includes among its objectives the improved utilisation of renewable energy sources, the reduction of greenhouse gas emissions, and giving priority to eco-efficiency, which together influence changes in the urban climate.

The publication you hold in your hand has been prepared upon the initiative, and with the coordination, of the Hungarian EU Presidency, and has benefited from the welcome participation of several European countries and cities. Our initial assumption is that city-level responses and local action have a significant responsibility in protecting the climate and in achieving sustainability itself. This, in turn, requires an integrated strategic approach. In co-operation with the relevant national and EU policies, economic actors, and social partners, city and city region leaders are indeed capable of taking action at city level to mitigate climate change's influence on our lives and to ensure that, thanks to appropriate means of adaptation, the changes do not threaten the quality of life of European citizens.

This handbook has been created for city management teams, decision makers, public officials in charge of management processes and skilled staff to support their work. Adopting an integrated approach, the volume covers nearly all fields of city development and management. However, given its comprehensive nature, for specialised professionals it offers only a limited amount of in-depth technical knowledge.

This handbook is only one step amongst many to promote urban climate protection. This important field has already seen the publication of many studies and even methodological documents; our volume has been able to build upon these works. As an additional step, this handbook not only summarises some of the results achieved so far but also arranges them into an entirely new structure, from the perspective of the actual means and fields of interventions at the disposal of the local governments of European towns and cities.

We are fully aware of the fact that the knowledge of climate change adaptation expands on an almost daily basis. For this very reason we encourage readers to adapt the recommendations found in this handbook to their own cities' circumstances, to develop and expand them and thereby to contribute to the wealth of our commonly shared European knowledge on urban climate.

Dr. Sándor Pintér
Minister of Interior, Hungary

EXECUTIVE SUMMARY

Climate change is a serious global challenge, which will significantly influence the life of the citizens of European cities. Europe is an urbanised part of the world, where two thirds of population live in urban areas.

The role that towns and cities can play in tackling the effects of global climate change in terms of emission reduction, mitigation, and adaptation is fundamental. Cities and towns are responsible for most of the global energy consumption and global emissions. In Europe, 69% of all greenhouse gas emissions are generated in towns and cities. Besides the causes, the negative consequences of climate change are also concentrated in urban area, which are often more vulnerable to its impacts.

City-level response and local action are to shoulder a significant part of the responsibility for the creation of climate protection and, in general, sustainability. In co-operation with the relevant national and EU policies, the economic players, and the social partners, the leaders of cities and urban regions are indeed capable of taking action at city level in mitigation and adaptation, as well.

With the publication of the 'Handbook on Climate-Friendly Cities', the Hungarian Presidency has contributed to this issue with the aim of supporting cities and urban policies. To avoid the negative effects and benefit from the opportunities offered by climate change creative, well-prepared city leadership and flexible and adaptive management are needed. This publication aims to provide city management teams with European knowledge on cities' tasks and their opportunities.

Geographically, the climate challenges that cities and towns across the European Union face show a great deal of diversity, no unified policy model or standard solution exists. However, there are a range of approaches and possible measures that can be used effectively in most individual cases, with the necessary adjustments. The opportunities open to cities and towns for action address nearly every aspect of urban development and city management, all the way through to the everyday life of citizens and institutions. By cutting public budgets the economic actors will have to play a more and more important role, thus local governments should develop strong policies to encourage a green economy and local economic development.

The Handbook introduces the main areas in which cities can act in relation to climate change. It describes the means and possibilities - as pillars of climate friendly cities – potentially available to city authorities that can be put to good use in the areas of both mitigation and adaptation. Local authorities have many direct tools, such as their institutions, local regulations, taxes, financial incentives and investments, for the mitigation and adaptation. However, the means by which they can influence other actors are of the same importance. We have to emphasise the crucial importance of integrating strategies and governance aspects, which can ensure good combination of using the proper tools.

The Handbook's key messages, which together define the pillars of the climate-friendly city, can be summarised in the following 8 main points:

1. The 'climate partnership' and multi level governance in city regions

Cities and towns are recommended to create a broad and systematically organised partnership as follows:

- *Co-operating with national, regional authorities, municipalities of the functional urban area as well as sectoral agencies.*
- *Shaping the urban climate policy within the framework of a widely based, permanent and well organised partnership that integrates both the residents and the civil and economic actors.*
- *Integrating climate-friendly aspects at every stage; from regulation and disseminating information among the population and the economic actors, to designing incentives, and the operation of public services. The more areas of competence city governance can rely on, the stronger urban climate policies will be.*
- *The city's economic policy may be an important tool in shaping an urban climate policy, if it is able to follow the goals and principles of green economy and strengthen the local economy based on local resources.*
- *Sharing the knowledge and the experience of climate policy initiatives with other cities and towns, and the national and EU institutions, preferably through city networks.*

2. Climate planning in integrated strategies:

Cities and towns should integrate climate aspects into their strategies along the following principles:

- *connecting urban climate planning to the development and management procedures of the city in an integrated, multilevel approach, dealing with opportunities for both mitigation and adaptation;*
- *indication of climate-awareness in all of its steps of planning (situation analyses, the objectives and means, follow-up, etc.) when performing urban strategic planning process involving the climate aspects.*

3. Climate-friendly spatial structure of the city through planning and zoning

Cities and towns should aspire to

- *create compact urban structure, in which interactions are intense, transport distances are moderate and urbanised land use is restricted in space with efficient energy networks;*
- *divide urban structures to non-built-in areas, green zones, zones ensuring ventilation;*
- *reduce travelling and transport needs within and outside the city; territorial optimisation of locations of jobs, residential areas, services and transport lines;*
- *develop polycentric pattern of the city region and in the inner structure of the cities;*
- *extend urban green spaces, and develop their quality, linking them into networks;*
- *prefer investments into brown field areas and avoid green field developments.*

4. Urban - rural (city and its surroundings) co-operation

Local governments, relevant and private and societal actors should cooperate in order to

- *strengthen the co-operation of the city and rural actors, based on division of labour in order to avoid urban sprawl, prevent the intergrowth of the built-up areas, increased energy consumption and loss of spaces with ecological function;*
- *limit the sprawl of built-up areas, avoiding rapid transformation of peri-urban rural and natural green areas; unavoidable extension of the city should follow linear community transport lines;*
- *increase the food supply the city obtains from its region, and with this, shorten the distribution chain within the region.*

5. Disadvantaged social groups and social effects

In order to help disadvantaged social groups and consider social effects, cities and towns are recommended to

- *take into account the interests and vulnerability of the deprived social groups, who also need additional support to adapt to the changing circumstances. Disadvantaged urban social groups are particularly vulnerable to the impacts of climate change;*
- *carefully monitor the possible negative social effects of the adaptation and mitigation measures and should any arise, take counterbalancing measures, paying particular attention to deprived urban areas.*

6. Climate-aware architectural solutions

In the regulation and development of local architecture, culture cities shall put emphasis on

- *mitigation – energy-efficient building solutions (e.g. passive houses, low carbon building);*
- *reducing energy consumption of households (heating, lighting), alternative energies (e.g. solar, geothermal);*
- *water saving and recycling solutions in architecture;*
- *adapting buildings to extreme conditions;*
- *designing buildings using a holistic, energy-cost-emission assessment approach, for the whole life cycle.*

7. Climate-awareness and lifestyle

Local authorities are recommended to increase the environmental responsibility of the individuals.

The usual lifestyle can be influenced by education, cultural activities, communication campaigns, events and other investments in order to

- *strengthen shared responsibility for the state of the urban environment and common social values;*
- *encourage environmentally-aware lifestyle, transport, consumption and market demand;*
- *share knowledge on the consequences of climate change;*
- *promote the utilisation of local resources, marketing of local products;*
- *increase the ability of civil society and churches, cultural institutions and social groups to strengthen cohesion of local communities.*

8. Sector pillars supporting the climate-friendly city

Cities and towns should incorporate a climate-friendly approach into their sector policies, as a horizontal aim, by

- *helping prevent climate change by functioning as local markets and strengthening an autonomous economy encompassing both the city and its rural environment, which aims to satisfy local needs from local resources;*
- *creating low carbon urban transport systems, with competitive and safe public transport, giving preference to pedestrian and cycling mobility, technical adaptations to changed climate in services (shading, air-conditioning, infrastructural elements, etc.) and monitoring;*
- *ensuring efficient and energy-saving management of cities and towns by combining green and local energy production with local economic development, using renewable energies, biogas production from municipal waste, etc.;*
- *organising urban water management as natural hydrological systems, together with the settlements of the catchment area;*
- *preparing disaster management and health care services to manage the increasing risk of hazards (floods, sudden heavy rains, sea-level rise, heat waves, water scarcity, industrial disasters, etc.) and be ready to tackle sudden healthy, security, disaster challenges.*

This Handbook was written for decision makers, politicians, professionals and stakeholders; for those involved in urban, territorial and sector policies in the Member States, for those working at European level, and especially for those serving the cities and towns of Europe. They are recommended to use and disseminate this Handbook, act upon its recommendations, and initiate further national and local reflection and debate on this topic. This Document serves as a knowledge resource and a starting point to its readers who may feel free to acquire its recommendations and combine it with their own experiences.

INTRODUCTION

Global challenge with urban relevance

Climate change is one of the most important global challenges of our age, and there is an almost full consensus on it being an anthropogenic phenomenon. Over the past one hundred years, global surface temperature has increased by 0.74 °C and global average sea level has risen by 17 cm. Should the current trends continue without a significant reduction in the emission of greenhouse gases (GHGs), during the next few decades we will witness irreversible processes that might bring along major changes in our social, economic, and environmental systems. The impact of climate change is different in the various European regions and greatly depends on the extent of climate change, on the sensitivity and exposure of the various ecological, social, and economic systems, and on the adaptability of the given society. Facing up to these challenges in a satisfactory manner requires a paradigm shift in development thinking and makes the earliest possible transition to a low carbon economy an urging necessity.

The challenge of climate change, on the one hand, requires a fast and early reduction in greenhouse gas emission both in Europe and at a global level. Europe is responsible for approximately 12% of the annual global anthropogenic direct GHG emission and makes significant efforts to curb emissions both at the global and at the European level. The European states and the European Union take significant responsibility on the environmental status of our planet, Earth. This is directly addressed by the Europe2020 Strategy and the related efforts are supported by EU funds. In addition to reducing emissions, the issues of adapting to a changing climate are becoming more and more prominent as well, especially with a view to the facts that the effects of emission reduction will only emerge with a delay, and that by now climate change has become our unavoidable reality. Europe’s regions and economic sectors are varied in terms of their climate change vulnerability; as a consequence, the peculiarities of the individual areas, among other considerations, must also be taken into account when elaborating strategies of adaptation. Various research projects have supplied proof that even though adaptation entails significant costs, timely and proportionate intervention is more efficient than not adapting to the inevitable changes.

Two thirds of Europe’s population lives in urban spaces, and the role cities play in the context of climate change is undeniable. Cities are responsible for 60% to 80% of global energy consumption and of all global emissions. In Europe, 69% of all greenhouse gas emissions are generated by towns and cities.

Climate change challenges and the Europe 2020 headline targets

The target values of some main indicators of EU 2020 Strategy can be achieved through a sound support of climate change related urban development interventions:

- The climate and energy target of ‘20/20/20’ **(Target 3 on cutting greenhouse gas emission, increasing energy efficiency, and supplying energy needs from renewable sources**) has a direct relation to cities, as the source and focus of energy emission and consumption.
- **Target 1, increasing the employment rate (from the 69% to 75%) of the population (aged 20-64)** can be supported through the green economy and local economic development that are key elements of the economic policy of climate-friendly cities. These green-growth related interventions have a high labour intensity requiring qualified and untrained employees as well.

- The climate-friendly urban development and management activities may significantly contribute to **Target 2, on raising investment in R&D (to 3% of the EU's GDP).** The often technology-intensive mitigation and adaptation actions require innovative solutions; these rapidly spreading, innovative solutions are frequently locally developed or require local adaptation and improvement. However, climate change itself, especially as an urban phenomenon, requires a lot of applied research on global, regional and particularly on local level.
- Social groups living in poverty and suffering from exclusion are more vulnerable to the negative effects of climate change. The climate change adaptation actions of the cities and towns – especially if they take affordability and the special position of disadvantaged social groups into account – can significantly improve the living conditions of these groups as well. These efforts can create new opportunities for **Target 5, to lift these groups out of poverty contributing to the target on reducing the number of Europeans living below the national poverty line (by 25%).**

Because of their location and nature (e.g. towns and cities built near the sea or on floodplains), the high rate of disadvantaged and elderly people living in urban spaces, and the high concentration of infrastructure systems and economic activity in urban areas, cities are especially vulnerable when it comes to rising sea levels and extreme weather events. Without appropriate measures, this vulnerability represents an increasing challenge to both central and local authorities, local enterprises, and local residents. Thus cities are key areas of climate protection, where efforts can be more effective than in other areas. At the same time, it also presents an opportunity for adopting timely and appropriate decisions and measures.

The causes of climate change, and especially the causes of warming, are highly concentrated in cities, and this is where the effects and the emerging problems are also most prominent. The built-in surfaces of urbanised areas warm up to a greater extent. Greenhouse gas emission is also concentrated here mostly because of the intense traffic; this is where the contribution of the direct heat impact of infrastructure systems, heating systems, traffic, and production – something we call heat pollution – is also the greatest; at the very same time, densely built-in urban spaces allow for less air displacement and thereby less natural cross-ventilation. Of course, other than warming, built-up areas also experience dynamic changes in a range of other ecological conditions such as changes in air humidity and water balance. Potential risks related to climate change - such as natural disasters, shortage of food or increase of food prices, etc. - threaten more intensively urbanised areas, where more people are influenced by certain impacts.

All this means that the role towns and cities play in tackling the effects of global climate change in terms of emission reduction, mitigation, and adaptation is fundamental.

Goals and approaches of the Handbook

Entitled *Climate-friendly cities*, this Handbook has been created with the mission of helping city management teams and their specialised expert staff as well as various urban development practitioners make urban settlements climate-friendly by summarising and building on the European knowledge and experience thus far accumulated in the area of climate change and especially its urban aspects. The objective of this volume is to take account of the means and possibilities potentially available to city authorities that can be put to good use in the areas of both mitigation and adaptation. This Handbook identifies the opportunities at the local, that is, city and urban region level. For this very reason, it does not cover national policies (regulation, investments, etc.) even though their importance in the context of combating climate change is more than obvious. The Handbook addresses not only the cities, but also towns and all the settlements of an urban character, even in rural areas.

Geographically, the climatic challenges that cities across the European Union face show a great deal of diversity, while they remain an issue affecting nearly every sphere of urban development and city management, all the way through to the everyday life of citizens and institutions. Obviously different geographic locations provide totally different circumstances and in some types of territories the essential core of economic activity can be modified by climate change. For example, cities in costal zones and particularly on islands are particularly affected by changes in sea-level, river basins and plains can be threatened by the increased risk of floods, whilst winter sport opportunities can be limited in the mountainous region.

Consequently, no unified policy model or standard solution exists; however, there are a range of approaches and possible means that can be used effectively in most individual cases with the necessary adjustments.

Beyond the climate protection issues, the Handbook adopts also the approaches of pro-activity and utilisation of existing possibilities. Climate change is not only an environmental challenge for governments and cities but also an economic opportunity to strengthen their competitiveness at a European and global level and to create new jobs. Innovation in tackling and mitigating the effects of climate change and adapting to its consequences is a factor in increasing the attractiveness of particular areas; in addition, it is also a factor in conserving resources – more particularly, water resources. At the same time, we also draw attention to the potential social effects of urban climate change, as well as to the potential social effects of the climate protection measures proposed in this Handbook.

This Handbook cannot address all the issues of urban climate; it concentrates on the practical solutions, which are relevant for local level authorities. This volume dedicates only a limited amount of space to theoretical considerations and analytical background; instead, it places emphasis on practical action, providing a toolkit for city management.

At the same time, the volume makes an effort to present all major groups of action at the level of cities and urban regions, using specific examples of best practices elaborated by various European cities. The comprehensive nature of this approach clearly allows only a limited amount of in-depth technical knowledge to be included for the specialised expert. The primary function of the document is to **offer a summary of the knowledge** that is already available to us and that is expanding almost on a daily basis, while it only occasionally endeavours to elaborate new solutions; an example for the latter could be our methodology for climate-integrated strategic planning.

The efforts of the Hungarian Presidency in the field of urban climate change is supported by the European Urban Knowledge Network (EUKN, www.eukn.org), which dedicated a specific key dossier to the issues of the Handbook in its e-library under the coordination of the Hungarian EUKN focal point. The development of this urban climate knowledge is also coordinated with the Reference Framework for Sustainable Cities (RFSC) initiative.

The volume has had the chance to build on the technical documents and good practices of a large number of European cities and countries. Many policies of the European Union have also provided fundamental cornerstones for developing this Handbook; in addition to policy documents related to climate change and urban development, we have also considered EU transport policy and energy policy. Special mention must be made of the European strategy for sustainable development and urban environment and other international agreements on sustainable development, as well as the European Commission's Green Paper on adapting to climate change in Europe.

Quite a range of technical documents have already been drafted on the issue of cities and climate change. We must mention the Organisation for Economic Co-operation and Development (OECD) 2010 publication entitled Cities and Climate Change; this reviews the relevant trends, the relevant competition policies, and the related governance issues with scientific accuracy. This OECD volume, which reviews the overarching processes of climate change, is well complemented by the Handbook prepared by the Hungarian Presidency, as it endeavours to present the available means and opportunities in a practical manner and with a focus on Europe. It is important to mention that OECD reports explored other climate-related aspects in a comprehensive way, with a strong focus on the economic consequences, providing a crucial contribution to common efforts in the field.

We believe that cities can apply various approaches and instruments to implement their climate change policies. The cities' competency in selecting the proper elements of their climate governance is determined by their legal status in the state administration. However, there is always an opportunity for creative actions. In our opinion, creative solutions can serve as inspiration for other cities; accordingly, the volume dedicates much of its space to good European examples in each thematic area. The best practices described in inserts have been realised with the direct contribution of EU member state ministries and European cities.

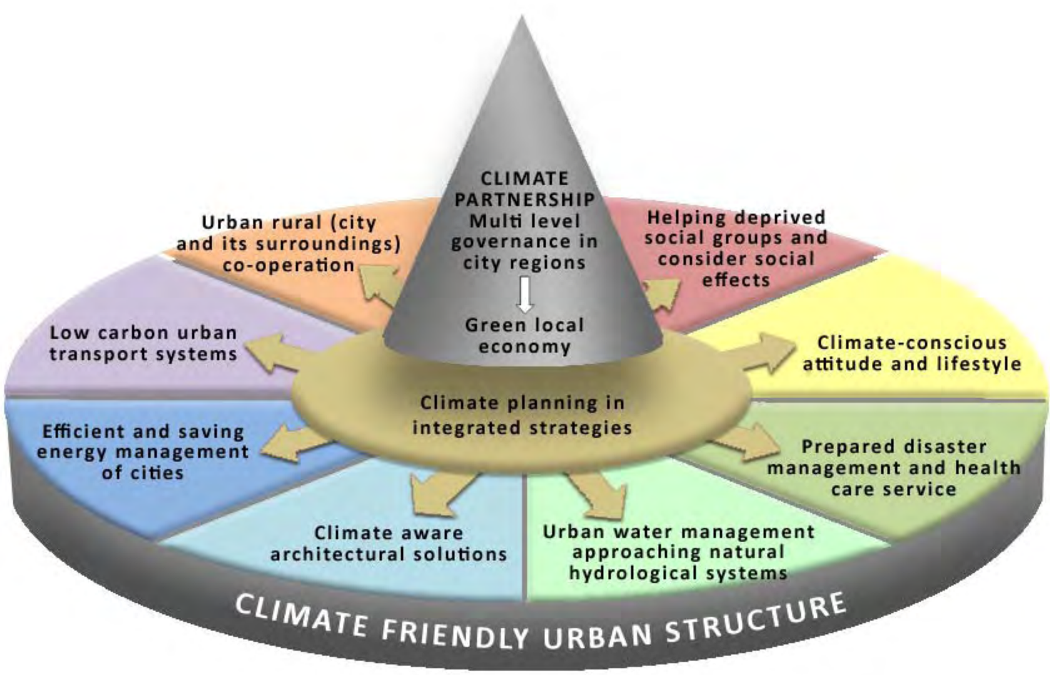
The real strengths of this volume lie in its integrated approach, which is geared to utilising the existing possibilities, and in its practical focus. The real novelty that this volume brings is its structural approach: it reviews, from the perspective of urban climate related considerations, those sets of instruments that local governments are able either to create or to influence.

The logic of the Handbook - The pillars of the climate-friendly city

The structure of the handbook follows the different fields of possibilities and tasks of cities related to urban climate.

The general idea behind the Handbook is that the climate-friendly city as a concept can be realised via various types of activities in quite a wide range of sectors and spheres of city management. In this concept there are different pillars - fields of intervention with proposed approaches - which can ensure the climatically positive development and character of the cities.

Most of them are different sectors of urban management such as transportation, energy management, certain public services, architecture, water management, etc. However, there are three key pillars, which have more horizontal and outstanding importance: governance, climate-aware, integrated strategic planning and the proper spatial structure of the city supported by zoning policy, which has significant influence not only on the climate itself, but also on the opportunities of all other pillars in different locations. The pillar model of the climate-friendly city can be seen in the diagram below.



The pillar model of the climate-friendly city as the logic of the Handbook

How to use the Handbook – The structure

Let us provide some help on how to use this publication efficiently.

The general structure of the Handbook follows the pillars of the climate-friendly city as introduced in the previous subchapter. The colours of the above diagram help the reader to navigate within the Handbook as these colours are used in the table of content indicating the relevant chapters. In discussing the tasks and opportunities cities have in relation to combating climate change, the chapters of the Handbook almost always cover both mitigation and adaptation. These two aspects appear in separate subchapters, where relevant.

This publication is an extensive Handbook, which provides different options on how its content can be used. Due to to its remarkable length **reading the whole document** is quite challenging. This is not expected from most readers.

You can gain a quick overview of **all the chapters,** to a certain extent if you look at the **brief recommendations** at the end of each chapter. These are summaries of the main messages of the given chapter. In many chapters illustrations also help understanding.

If you need detailed information on a certain area then you should read the given chapter in detail.

If you need good examples or want a more practical insight into a particular theme you can find **good practice** from all around Europe in the boxes. 78 excellent case-studies were contributed by urban authorities and ministries of the EU member states, plus Switzerland and Norway. In each box you can find a link to contact the relevant organisation, to get more information, or to build co-operation.

The **Appendix** of the document provides more practical information for the readers. The list of the most relevant European regulations, directives, climate related urban policy documents and the main European networks of organisations in the field are important starting points to find additional official information and to build partnership and cooperate in this field. The set of urban climate-related indicators provide assistance for the implementation of the proposed measures of this Handbook and for the evaluation of their results.

In the following we intend to help the readers to get a very basic understanding of the **content of the chapters** of the Handbook, which might help when searching for particular information.

The Handbook starts with the identification of the phenomena of **urban climate** and the impacts global change has on it. The first chapter of this volume aims to identify the peculiarities and the possible impacts of **urban climate** and its changes, focusing on the significance of such impacts, while taking geographic differences within Europe into account.

The authors believe that the first pillar of all the efforts is the appropriate **governance**, which must be multilevel and ensure the ongoing partnership in climate protection. Furthermore, integrated planning should be the general tool of coordination. The second chapter also addresses some key cross-cutting issues, such as climate-friendly public procurement and ensuring climate justice.

Chapter 3 of this volume offers a more detailed and, one might say, innovative methodology to support the elaboration of **integrated strategies**, which deeply include climate aspects. Step by step guidance for integrating climate aspects in strategic planning is a practical tool for all cities in this chapter. Decision-making and planning must be based also on climatic models, predictions/forecasts.

Regular urban environmental data collection, monitoring, communication and also the transparency of information are essential aspects of climate-friendly governance and planning.

The volume places special emphasis on **shaping the structure of cities**. Spatial structure is best shaped through zoning policies. However, since the spatial structure that is most favourable in terms of climate considerations can be very different from one region to another and from one city to another, we introduce a set of general criteria that may be valid for most regions, dedicating special attention to the relationship between urban and rural areas and the phenomenon of urban sprawl. The relations between the city and its rural surroundings are important in almost all cases from the point of sustainability. The issue of green surfaces also gets increased attention in the 4th chapter.
Transport is the main source of urban GHG emissions, therefore it is a priority field where cities can act. Preferred types of urban transport, attitudes to transport, and also adaptation possibilities are addressed in the 5th chapter.
As described in chapter 6, cities have instruments to influence the **energy management** of the city to enhance energy efficiency and conservation.

When it comes to urban development, the importance of architecture, its local regulation, and its local practice is more than obvious. Today, European **architects must** realise how important sustainability and climatic considerations are. The possibilities of building regulation, methodological development and sharing knowledge in the context of climate change related adaptation and mitigation are expanding spectacularly. Key approaches and good solutions of architecture are introduced in chapter 7.

Chapter 8 gives guidelines for integrated **urban water management**, which should shift towards the natural hydrological systems, conserving and retaining water and being prepared to manage sudden events, sea level rise, and other risks.

Local authorities have a huge responsibility in managing different natural disasters, and health consequences. The institutions responsible for disaster **management and health care** services must be ready and prepared to tackle sudden events.

As introduced in chapter 10, local authorities and also national, regional urban policies can increase the people's awareness and promote climate- and environmentally-friendly attitudes and lifestyles.

Disadvantaged urban social groups are particularly vulnerable to the impacts of climate change. Their interests and risks must be taken into account and they need additional efforts to adapt to the changing circumstances, particularly in the deprived urban areas.

There is a separate chapter dedicated to the **economic consequences** of both mitigation and adaptation and to strengthening urban economy. The green economy and the development of the local economy are introduced in the 12th chapter. Although it emphasises the economic dimension of the climate change issue, it neither undertakes to give a general overall picture on public funding opportunities nor introduce methods to measure economic impacts. However, in this respect we recommend the Computable General Equilibrium Model of Cities and Climate Change published in the 'Cities and Climate Change' (OECD, 2010).

Urban adaptation and mitigation measures might have **social affects**, which need higher attention and might need counterbalancing measures.

This knowledge introduced in different chapters of the Handbook are recommended to combine with the locally accumulated experiences of the readers. We do hope, that this joint effort of readers and authors can contribute to complete your urban climate related tasks more affectively in the future.

1. 'URBAN CLIMATE' AND ITS EXPECTED MODIFICATION DUE TO THE IMPACT OF CLIMATE CHANGE

1.1. URBAN CLIMATE

The determinant characteristics of cities, i.e. high level of built-up density prevailing in large areas, significant industrial activity and heavy traffic, fundamentally influence the factors responsible for the development of the climate. As a result of this a mezzo climate largely different from that of neighbouring regions evolves in cities. Owing to its prevalence and typicality, this mezzo climate with special features has even been given an individual name: urban climate. Understanding its characteristics, its forecasting, as well the development of preventive actions are the subjects of serious scientific research.

The most thoroughly studied partial phenomenon of the urban climate is the '**urban heat island**'. This definition refers to the fact that the surface temperature of cities significantly exceeds the values measured in surrounding areas of settlements. This holds serious public health risks for city dwellers. According to measurements, the annual average surface temperature of Paris is higher than that of its outskirts by 1.7°C; this value with respect to Budapest is 1 to 1.5°C and in the case of London 1°C. In winter time and at night there are more favourable conditions for the formation of urban heat islands; at the same time, increased wind speed and the growing extent of cloud cover have a balancing effect to the differences between the temperatures of cities and their outskirts.

The development of the urban heat surplus is the common result of several factors. The most important of these are the accumulation of dust and greenhouse gases in the air layers above cities, and the low albedo and fragmented morphology of city surfaces. A further factor is due to the high reliance of cities on external energy sources which leads to additional heat emissions.

Due to typical urban activities the radiation balance of large settlements is significantly different from that of the natural environment surrounding them. A large quantity of aerosol and greenhouse gases gets into the atmosphere as part of transport and industrial emissions. Aerosols are tiny, colloidal-size particles serving as condensation cores in the generation of precipitation. Therefore, their presence increases air moisture content. As a result of high vapour, dust and greenhouse gas concentration, a dome containing these substances forms over cities, which leads to a significant (15 to 20%) decrease in short-wave radiation reaching the surface. At the same time warm air gets stuck close to the surface because of the retention of long-wave radiation. Consequently, owing to anthropogenic pollution, an increased greenhouse-effect prevails in the air layers over large settlements.

The low albedo of the urban ground surface plays a significant role in the formation of urban heat islands. Of construction materials used, asphalt has a particularly low albedo, while concrete and brick walls also absorb a significant quantity of short-wave radiation. Due to fragmented morphology of the surface, the stored energy quantity can leave in the form of long-wave radiation only to a limited extent. This occurs because part of the emitted heat gets absorbed again on the surface of buildings and plants and is radiated back towards the surface. As a consequence of all the aforesaid, reemission of heat absorbed during the daytime reaches into the night. This prolongs the starting time of relief from heat in the evenings, which predominantly contributes to the increase of the daily mean temperature and the formation of the urban heat island phenomenon. At the same time, by careful city planning, the fragmented surface may contribute to the formation of cold inflows mitigating the urban heat surplus by creating the possibility of cross-ventilation.

Residential, industrial, commercial and transport heat energy emissions originating from the burning of fossil fuels also play a role in the formation of urban heat islands. Measurements indicate however that the significance of anthropogenic heat production in the formation of urban heat islands is only secondary compared to the surplus heat originating from the different heat economy of artificial surfaces. This is well proven by the fact that, based on examinations carried out in cities located in plain areas and far from open water surfaces, there are significantly higher heat island intensity values in non-heating periods than in heating ones. In addition to the direct effect occurring through the emission of heat energy, the burning of fossil fuels contributes also in an indirect way to the formation of urban heat islands through the greenhouse-effect caused by the emitted pollutants.

The surface temperature of cities is further increased due to the high proportion of paved surfaces, as the majority of the rainwater flows off and, therefore, less moisture gets into the surface ground layer. Consequently, in the dry periods less water is available for the evaporation, which has a cooling effect. This in turn increases the warming of the urban atmosphere. As a result of the low extent of evaporation, the humidity of the air layers near to the surface of larger settlements develops in a peculiar way. Relative humidity is considerably lower in settlement districts characterized by high built-up density than in the outskirts and districts comprising large green areas. The difference is especially significant in periods with low air motion, when atmospheric humidity of districts may differ by several percentage points. In extreme cases an **artificial desert climate** may develop in downtown areas with 20 to 50% relative humidity values.

As a result of the high warming experienced in inner districts of settlements, in these areas the air strongly rises and its place is taken by the inflow of cooler air coming from the outskirts of the settlements and neighbouring regions. In case of clear and calm weather an individual local wind system, so-called **urban wind** develops in areas that can be characterised with high built-up density. Urban wind has a dual significance. On the one hand, being particularly strong in the evenings it helps to mitigate and to bear more easily the urban heat island effect. On the other hand, it helps to clear the polluted air of cities. In forming the urban structure, the prevalence of these favourable impacts is assisted by taking the wind directions and channel effects into account and preventing or terminating the establishment of potential blocks. In case of settlements located on hillsides with surrounding areas covered with forest (which warm up less during the daytime) cold air ‘flowing down’ from the higher levels has great significance. Favourable effects similar to those mentioned with respect to urban wind can be achieved by developing the urban structure optimally, enabling cool air coming from higher parts of the hill to flow unobstructed towards the slopes. As a result of special urban circulation systems (characterised by frequent lifting) and the great number of condensation cores originating from dust pollution, the **quantity of precipitation** in densely inhabited settlements is on average 5 to 10% higher than in the neighbouring areas.

1.2. CONSEQUENCES OF CLIMATE CHANGE IN EUROPEAN REGIONS

Impacts of climate change (e.g. the increase of annual average temperatures and the temporal and spatial modification of the quantity of precipitation) appear in an intensified and concentrated manner in cities. The above described characteristics of the urban climate show the relatively higher proportion of extreme periods compared to surrounding areas. The climate of peri-urban regions becoming more extreme further enhances unpredictability of the urban climate, which is anyhow inclined to extremities. The exposure of cities to climate change is topped by the consequences of climate change affecting large geographical regions (sea level rise, droughts, floods), that appeare in cities, as well. However, the extent of the expected changes and major hazard factors show significant differences between individual regions of Europe (EEA, 2008b)

Figure 1: Most important sector specific impacts of climate change and their consequences in the major European biogeographical regions. (Source: EEA 2008b)

1.2.1. Expected tendencies of major climate determining factors

Since the beginning of regular measurements based on a uniform method (1850), the **annual average temperature** has shown a clearly increasing tendency all over Europe. In the 12-year period between 1996 and 2007 eight years are among the twelve hottest ones ever measured. Based on the forecasts of climate models, the tendency continues: in the last two decades of the 21st century the annual average temperature of Europe will exceed the average temperature of the period from 1966 to 1990 on average by 1.0 to 5.5°C, depending on the models applied. However, there are great regional and seasonal differences behind the even increase of the annual average temperature. A significant increase (which might even exceed 5°C) of average winter temperatures is expected in the Northern part of Europe (mainly in the region of Scandinavia and Finland) as well as in Central and Eastern Europe, and an increase of similar magnitude in average summer temperatures is expected in area of the Mediterranean.

Out of the **periods of extreme temperatures** the length and intensity of the summer heat waves have increased in the entire territory of Europe, while the number of frosty days has decreased in the past century. According to the forecasts of climate models, the greatest increase of the daily maximum temperature values can be expected in the currently already hottest Mediterranean region. By the end of the 21st century, the number of tropical nights causing public health problems (minimum temperature of over 20°C) may reach even 30 to 40 in the non-upland areas along the Mediterranean and Black Sea, and 20 to 30 in the Carpathian Basin and in the South-Western regions of France. Furthermore, the number of frosty days may considerably decrease also in Scandinavia, which is already affected most by periods of extreme temperatures.

Past and expected future development of **precipitation conditions** shows significant regional differences. Based on the calculations of climate models, tendencies started in the 20th century continue further. Accordingly, in Northern Europe the annual quantity of precipitation increases, particularly in the winter period (by approx. 20%), while in the rest of Europe the annual quantity of precipitation is expected to decrease, to an increased extent to the South. On the Iberian, Apennine and Balkan peninsulas the average summer precipitation of the last two decades of the 21st century may even halve compared to the last two decades of the 20th century.

Out of the periods that can be characterised by **extreme precipitation conditions**, the frequency of both high-intensity precipitation conditions and dry periods are expected to permanently increase in most of Europe. The number of extreme precipitation events is expected to further increase in accordance with the tendencies experienced at end of the 20th century, even in regions (the Mediterranean and Central Europe) where annual volumes of precipitation are expected to decrease. The number of extreme precipitation events will increase by 17% in Northern Europe and by 13% in Central Europe, at the same time no significant change is expected in Southern Europe in this respect. It is particularly alarming that, according to the results of the climate models, the length of extreme precipitation events also shows an increasing tendency. As a consequence it is expected that the number of periods characterized by ideal conditions for the formation of floods will increase. Based on the data of the past 50 years, increase of the length of dry periods can only be demonstrated in the winter, mainly in Central and Eastern Europe and Western Russia. At the same time, according to the forecasts, long summer drought periods are expected to occur in the basin of the Mediterranean Sea. Here by the end of the 21st century the length of dry periods characterised by less than 1 mm of daily precipitation quantity may exceed the current length even by a month. In Central Europe the length of drought periods will 'only' increase by a week, while in other parts of Europe periods characterized by permanent drought are not yet expected to develop.

1.2.2. Expected changes in the climate of European cities

Based on all the aforesaid, the climate of European cities is expected to develop in geographic regions of Europe as follows.

According to the forecasts, the climate of the **Northern region of Europe** (i.e. Scandinavia, Finland and the region of the Baltic Sea) will, all in all, be milder and rainier. Significant changes in comparison with today's climate are expected especially in the winter time. Average temperature increase in the winter months will gradually increase towards the North (in Lapland if may reach even 7°C). At the same time, summer average temperature will also be augmented and the difference may even reach 3°C. The quantity of precipitation may increase in most of Scandinavia and in Finland by 20 to 30% on annual average. In winter it may even exceed current values by 50%. As a consequence of warming tendencies, the number of snow-covered days may halve in the southern areas of Finland, in the territory of the Baltic States and in the coastal belt of Norway.

The increasing quantity of precipitation and the rising temperature tend to prevail more in cities than in the neighbouring areas as a result of the urban climate effect. As a consequences of all this, in cities located in the Northern region of Europe preparations must be made for draining and utilising the large quantity of precipitation in winters and for dealing with heat waves during the summers. The growing quantity of precipitation is expected to decrease winter energy demand for heating. At the same time in southern areas during the summer demand for cooling is expected to increase. However, hydro power being currently available in large quantities, mainly in the territory of Scandinavia, remains to be easily accessible.

In the **Atlantic region** (comprising the British Isles, Ireland, North-western parts of France and Germany, the Benelux States and the islands of the North Sea) yearly temperature is expected to rise in a nearly uniform extent of 2 to 3°C compared to the values experienced at the end of the 20th century. In most of the region the expected annual amount of precipitation will remain nearly unchanged compared to present values; an increase slightly exceeding 5% is expected in Scotland, and a similar decrease in Western and central areas of France. However, the seasonal distribution of precipitation will fundamentally change in the forthcoming decades: winter precipitation will increase considerably, by 15 to 50%, while the summer one will decrease everywhere; to a higher extent towards the south. The only exceptions will be in the northernmost territories of Scotland. Great storms accompanied by high winds will become more frequent and intensive in the entire territory of the region. In coastal cities in settlements located little above and particularly in those which lie below the sea level the expected water level rise poses a significant challenge.

As a consequence of all these, in the cities of the Atlantic region the main challenge will be the drainage of the excess waters in winters, drought appearing as a result of the decreasing quantity of precipitation and high temperature in the summers. Therefore, in this region it is practical to elaborate and apply technological solutions for retaining the immense amount of winter precipitation and storing it for the summer season. In the southern part of the region (especially in France) and even in northern areas, preparations must be made to deal with the significant increase in the frequency of heat waves. In the territory of France 20 to 30 tropical nights are expected by the end of the 21st century. This combined with a result of the urban climate will render night time relief from heat almost impossible in settlements with high built-up density during most of the summer.

In Central Europe (i.e. in the coastal regions of Germany and Poland, as well as in the Czech and Carpathian Basins) annual average temperature is expected to increase by a nearly identical extent, by 3°C. The climate models forecast an average temperature rise which is higher by 1°C in Poland during winters and in the Carpathian Basin during summers. The amount of precipitation is not expected to change in the southern parts of the region. In the northern parts a slight increase of 5% is expected. Similarly to the Atlantic region the annual distribution of precipitation will transform here, as well; in winters the quantity of falling precipitation will rise in the entire region, to an increased extent towards the North, while in summers it will decrease everywhere, showing an increasing tendency towards the South. This will cause serious damages particularly in the Carpathian Basin as here the annual amount of precipitation is the lowest within the region, already in current conditions. In Central Europe the number of drought days will grow from 20 to 25, typical of the end of the 20th century, to 30 to 35 by the end of the 21st century.

In cities of the region the biggest problem is expected to be the increase in the duration and intensity of summer heat waves, particularly in southern areas. In addition, challenges will include the increasing length of highly moist periods and increased quantity of the precipitation falling during such periods in winters. Due to the change of the nature of winter precipitation from snow to rain, the above conditions potentially lead to high floods suddenly cascading down. The drought during the summertime is expected to cause further problems.

In the **Mediterranean region**, with the exception of the islands of the Mediterranean Sea, the annual average temperature will increase everywhere by at least 3°C. In Andalucía and on the plains of Bulgaria the rise will be even higher. The increase of the average temperature of the summer period will be particularly high and may, with the exception of Southern Italy, even exceed 4°C. The quantity of precipitation shows a (in winter slight and in summer strong) diminishing tendency. In the western part of the Iberian, the central region of the Apennine and in the entire area of the Balkan peninsulas only two third of the total precipitation typical of the end of the 20th century is expected in the summertime. However, this region is not expected to be affected by exposure to the increasing threat from storms that is characteristic in other parts of Europe.

The climate of Mediterranean cities may become particularly extreme because of the urban climate effect. This is especially true for the summer period when a further increase compared to contemporary heat conditions is expected. Even in areas without buildings the number of tropical nights may reach 40 to 50. In cities this number is expected to be even higher as a consequence of the urban climate effect. In summer the heat can be accompanied by serious water shortage. This is made even more serious by the decreasing tendency in winter precipitation, which contributes to the insufficient filling of natural and artificial water storage facilities.

1.2.3. Social, economic and environmental impacts of the changing urban climate

The climate determines the life of cities in multiple sectors through in an interconnected system of relations. Therefore the changing thereof also effects many areas, sometimes causing simultaneous multidirectional changes. The situation is complicated also by basic local differences caused by geographical location. It is hard to set up a general scheme or lesson for these effects even within Europe. However, it is true by all means that the changing of environmental conditions fundamentally influencing the life of society sets new challenges exceeding usual duties, dangers and possibilities for the inhabitants, institutions and service providers of cities. Settlements react to these challenges according to their possibilities, socio-economic power and ability for renewal. Furthermore, for the elaboration of truly efficient and forward-looking answers, well-founded knowledge, rationality, inventiveness and collaboration are needed.

It seems to be unquestionable that climate change will not settle in a balanced state within a foreseeable timeframe. Therefore, the society too has to prepare itself for not a single transformation but for continuously changing environmental impacts. Consequently, permanently changing adaptation is required, comprising inhanced and renewing tasks in all affected fields.

As a consequence of climate change, the following natural conditions are expected in Europe:

– More frequent and longer lasting summer heat waves.
– Annual precipitation decreasing and becoming more and more irregular.
– High-intensity precipitation, increased frequency of rainstorms and hails.
– More variable weather.
– Prolongation and increased frequency of frost-variable periods in regions with long and cold winters.
– Strengthening and more frequent storms; increased chance for the appearance of tropical cyclones in the coastal regions of oceans, with simultaneously strengthening abrasion.
– Storms accompanied by stronger winds reaching previously protected regions, mainly in Central Europe.
– Strengthening and more frequent storm tides along seashores.

– Rising sea level.
– Permanent rising of the groundwater-level in coastal areas; local and periodical rise in areas prone to floods; decrease of the groundwater-level in most areas.
– By the general tendency of decreasing water yield of rivers, the likelihood of local inundations originating from sudden floods and downpours increases and the peak height of floods is expected to rise.
– Due to drier vegetation and high-intensity precipitation, surface erosion increases, mainly in Southern and Central Europe.
– Due to the varying groundwater-level the load bearing capacity of the soil may change and land slides may develop.
– As a result of the rise of winter temperature, less cold tolerant organisms appear and gain ground particularly in areas outside the Mediterranean region.

Concrete impacts are evidently connected the adaptation side of climate change. In connection this here we do not address mitigation of the emission of greenhouse gases, i.e. the modification of the factors bringing about the change. Furthermore, it is worth separating direct and indirect impacts. Direct impacts are settlement processes directly influenced by climate and weather, while indirect effects often appear as part of other, already existing socio-economical processes, strengthening, controlling, even hindering them. Evidently, direct effects are rather of ecological, healthcare and technical nature, while indirect effects can influence every segment of the life of settlements. In the following we summarise briefly from both aspects the impacts of climate change according to the life in, as well as in terms of fields of operation of settlements.

Among direct effects, those exercised on **health and the institutional system of healthcare** are of key importance. The impact of heat waves occurring parallel to increasing temperatures are well-known. Currently, summer heat waves are mainly typical of Southern Europe. However, as a result of climate change these are expected to occur more frequently in Central and Western Europe, as well. At the same time the inhabitants of countries located in these regions are less accustomed to high temperatures. Therefore the increase of the frequency of periods characterized by extreme temperatures entails an unusual risk for those living in a cooler climate. General warming is accompanied by the spreading of pathogens and their vectors, the extension of their activity periods (e.g. in the case of mosquitoes). Furthermore milder winters enable the settling of organisms that under earlier conditions have not been able to subsist in a natural way. The change in vegetation composition, and independent of this, the increase of periods with hot, non-refreshing air cause an increase in pollen concentration and resulting allergic symptoms. The expected more variable weather disproportionately impacts the sick and the elderly. Therefore not only the development of extreme temperature levels but also the speed of the change becomes a risk factor. UV radiation increasing parallel to warmer and fairer weather is also a significant risk factor, rising with less striking speed, however.

Indirect impacts of climate change, including the increase in weather-related disease and sickness, increased danger of epidemics, more frequent accidents due to floods, damages caused by storms, entail special duties as on the **institutional system of healthcare.** These also include taking care of the inhabitants affected by emergencies. Furthermore, as a result of summer warming, the energy demand of buildings increases. This may in turn influence the safety of energy supply. These are already direct effects.

The scope of the impacts of climate change is the widest with respect to **buildings and the built infrastructure**. The generally higher peak temperatures may cause obstructions in railway transport on the entire continent, as a result of the breaking of overhead lines and the deformation of rails. In the northern European regions frost variability with increasing impact can be highlighted. At the same time this also appears in the Central European region to a smaller extent, causing damage in buildings, pedestals, sculptures and road paving. The increased frequency and strength of storms damages buildings and transport cables all over the continent, both directly and through the of falling trees and posts. Current failures caused by the breaking of electric wires affect almost every field of contemporary life. Of the impacts of the more intensive precipitation, downpours and thunderstorms, the increased lightning activity and hails are the most dangerous for buildings as well as for almost every freestanding man-built structure. Downpours occurring in the summer period or at thaw may cause increased soil erosion, lead to the formation of gullies, the scouring of roads and buildings, and may trigger collapses practically anywhere in Europe. Subways, tunnels and underground systems are primarily endangered by inundations related to such events. At the time efficient ventilation in time of heat waves is also a difficult task to solve. Furthermore, changes of the groundwater-level may cause the shifting, dislocation, deformation and break of the soil, as well as of buildings and conduits.

In respect of **transport**, the most important are the impacts due to the above mentioned exposure of the infrastructure. In addition to the aforesaid, however, very important are also the impacts affecting people on the go, mainly in road transport. Heat waves in vehicles not supplied with air conditioning devices decrease the ability to concentrate and may cause sicknesses, which endangers not only the driver but passengers, too. The increase of the frequency of the extraordinary weather conditions (sleet, thunderstorm, strong wind) means a serious risk for unprepared vehicle drivers. Strong storms entail increase problems for sailing and aviation, too. However, the weaker winter ice cover lasting for a shorter time creates new and favourable possibilities for North-European sailing.

The impact appearing in the field of **water management and surface drainage** is also complex. In most of the continent, the water shortage due to droughts becoming more frequent and serious and the extraordinary danger of floods caused by downpours occur or appear simultaneously. Also from the aspect of the danger of floods, particularly important are such local floods and inundations caused by downpours as cannot necessarily be related to any watercourse. The groundwater-level may decrease or rise depending on the development of the precipitation and the infiltration but at the coastal areas increasing will be determinant due to the rising of the sea level. In terms of **drinking water supply**, the subsurface water resources providing the drinking water base are also endangered accordingly. At the coasts, the infiltration of the seawater into the sweet water layers because of the decreasing surface water recharge is particularly dangerous and may cause the deterioration of the drinking water base and an increased decay in buildings being in touch with the salty water. In case of drinking water exploited from surface and shallow water bodies the main problem is that the accessible quantity of water will be the least even in periods with increased water demand. The decreasing recharge may also cause the deterioration of the water quality.

In respect of **wastewater treatment**, problems are caused by floods in the combined sewer systems and by wastewaters being more concentrated due to the decreasing water consumption in the operation of wastewater treatment plants. In the field of **waste management**, the climate change effects to the greatest extent waste deposits being inappropriately designed and exposed to the danger of erosion.

In most of Europe the **urban green areas** are ab ovo exposed to increasing environmental stress due to the growing heat, drought and the spreading of thermophilous species and plant damaging insects. This is further increased by the increased use by the urban inhabitants as in warmer weather more and more people use the city parks more and more intensively. The vegetation exposed to greater environmental stress is less resistant to storms even when they are becoming stronger and more frequent. At the same time, thanks to the longer and warmer vegetation period, warming-up is beneficial to the flora of areas with a cooler climate.

In respect of settlement-level **energy supply**, at the time of the summer heat waves the most important impact is the growing energy demand of air-conditioning, but the damages caused by storms and the wind in the infrastructure and the line breaks are at least of the same importance, although rather unique events. On the other hand, because of the large electric networks overloading may occur also in systems not affected by any direct impact or damage. Finally, the mitigation and adaptation solutions of the other sectors may indirectly increase the demand for electric energy (switching from bus transport to subway or tram), which, from an energetics point of view, is a concomitant of the climate change. A favourable impact is the decrease of the heating demand because of the expectably rising average temperature and shortening, warming winters.

The direct impacts of the climate change firstly appear in the field of **economy**. The impacts outlined so far are primarily of technological and technical nature and their effect upon the economy clearly manifest themselves in the expenditures of production and services becoming more costly, since the effects of technical nature, even if less harmful, entail utilisations different from the usual loads and specifications, which requires either new (even if not necessarily more expensive) solutions or the strengthening and transformation of the existing technology. Depending on the climatic exposure, sometimes these expenses are quite high in certain partial fields in terms of national economy, e.g. in case of flood protection. The nowadays characteristic large supply systems, which are exposed to the environmental changes through transport and infrastructure, are more sensitive and vulnerable to these impacts. At the same time, the impacts of the climate change can be beneficial in many fields for the economy. The changing possibilities of agriculture appear in an indirect manner, in the strengthening or weakening of the situation of the neighbourhood of the cities. The generally decreasing heating demands are, theoretically, also beneficial but, due to the more variable weather, the costs can develop even reversely. With the exception of the Mediterranean region, the extension of the touristic season is a favourable effect but in the South the more and more serious heat waves may diminish the summer guest turnover. In the mountains the drastic rearrangement of ski tourism is already a currently existing process. The favourable ice conditions will have a beneficial effect on maritime trade in the coastal areas of the Northern, Baltic and Black seas.

The mitigation and adaptation solutions entail not only extra costs but with reasonable economy management they even may result in the appearance of new products and sectors, e.g. in the field of producing green energy. In case of a prepared economy, the expenditures of technical adaptation can also be kept in place, i.e. they may strengthen the local economy. Meanwhile, the economy is also the load bearer of social effects; the changes of the society appear here, too, although in a multiply indirect way. For the society, adaptation mostly entails extra costs and new tasks, which can only partly be entrusted to the civil sphere. The local governments and the state withdraw, even if obliquely, from the economy the money necessary for financing the aforesaid. At the same time, the impacts of the climate change can lead to beneficial changes in many fields of the economy. The production of modern and eco-friendly products and technologies is the so called sector of green economy. This new sector and its technical solutions that contribute to the adaptation to climate change can be a potential employer in the future. Creating new jobs can be an important step in the development of the local economy while cities can become more climate-friendly.

The **social effects** belong to the most varied impacts that are the hardest to forecast as mostly they are related to the natural processes triggered by the climate change only in an indirect manner. In cities, similarly to the environmental impacts, the social effects also appear in a concentrated and more acuminated manner. The changes mainly affect the disadvantaged groups (the poor, the old, the ill, the disabled and the minorities) as they have the least reserves that can be mobilised for adaptation. From a material point of view, the unfavourable change of the housing conditions (due to e.g. the heat waves, floods, more quickly deteriorating buildings) and the damages caused in movable assets and in properties by the extraordinary weather conditions, storms, floods and soil motions make these groups defenceless. Many times their preparedness is hindered by the lack of information either because of cultural segregation (e.g. in case of immigrants) or the low level of education. The changing of the urban climate may influence the status of certain city quarters, too, causing the dropping behind of quarters hit more strongly and the rise of others. The regional and even the international economic changes may improve or worsen the status of a settlement in the settlement network. And the changing of the economy or merely the living conditions causes more and more significant migration. The settlements are very sensitive to all economic changes; the regional and even the international economic changes may influence – improve or worsen – the situation of a settlement in the settlement network. This is one of the main problems that threatens us even nowadays. While taking efforts adapting to climate change we must support deprived social groups and the cities they live in. The aim of both the adaptation to climate change and the spatial planning as well is to decrease the territorial differences.

The role of **environmental safety** and disaster protection is generally important both from social and economic point of view. The most serious problem will be the increase of the frequency and intensity of floods, in particular quick and local floods. In addition, the growing frequency and intensity of forest fires is to be highlighted, especially because they have to be reckoned with in regions where, so far, they have occurred rarely and with little intensity, like in Central Europe. The variable weather endangers transport safety mainly in the winter period (stormy winds, sleet, lengthening of frost-variable periods in Northern Europe). Emergency situations may develop also because the increasing load on buildings and the infrastructure. All these will necessarily cause the spreading of **insurances** and, if not efficient measures are taken for increasing adaptation, also their becoming more and more expensive. From the aspect of the social and economic effects, the settlements and regions having larger reserves, technical and mental potential, stronger collaboration and a well-thought-out management can adapt themselves with better chances; therefore, the change may, theoretically, sharpen the regional differences. At the same time, these regions might have thanked their so far favourable position to environmental features whose change exceeds the adaptive capacity of the society, while elsewhere even the challenges of adaptation create new possibilities.

1.2.4. The role of modelling and the vulnerability assessment

The ongoing and foreseeable changes of the environment make the traditional planning methods obsolete in some respects. Not only in the case of technical details, but for certain development aims, it is not sufficient to build on recent data but the results of climate models have to be also taken into consideration. **Modelling** must be one of the underpinnings of the planning process. This is the case in the fields of flood prevention, land use, water supply and management, health services, and the provision of technical infrastructure. In coastal regions, for instance, it affects almost every aspect of urban development. Only this paradigmatic change can make the adaptation efforts effective enough. However, the greatest problem with modelling is a high level of uncertainty. Climate models provide different scenarios about future weather events so their impacts can be even more unpredictable. A wise solution is to consider the main trends of change (they can be more certain than concrete data) and the use of more (two or three) climate models.

Furthermore, the evaluation of foreseeable environmental changes leads to the necessity of **vulnerability assessments**. Vulnerability is in itself a very broad concept, and as a general term, it has a very limited usability. As every field and aspect of human activity and environment has its own interaction system, vulnerability also differs from case to case. Because the scale and characteristics of climate change vary across regions, the success of adaptation efforts depends on their regionally specific approaches. So, instead of conceiving vulnerability of a city in general, it is better to use this term for a particular city specifically related to floods, health, water supply etc. In concrete cases, the evaluation of vulnerability become not just useful but almost fundamental since it highlights the regions and activity fields where there is the greatest need for intervention.

The methods of vulnerability assessment use several indicators to predict the impacts of changing circumstances. For example, the Climate Change Vulnerability Index (CCVI), released by Maplecroft, evaluates 42 social, economic and environmental factors to assess national vulnerabilities. One of the widely used models for the assessment is the CIVAS (Climate Impact and Vulnerability Assessment Scheme) model, developed in the CLAVIER project carried out under the 6^{th} Framework Program of the EU. In this method, a region's or a city's vulnerability is evaluated on the basis of their exposure (to the changes in meteorological parameters), sensibility and adaptive capacity. The complex socio-economical and environmental climate-vulnerability evaluation of the LAU1 regions in Hungary has been performed relying on the CIVAS model. Vulnerability of the micro-regions has been assessed along four topics related to climate change: drought, loss of biodiversity, forest fire, heat waves. The evaluation has resulted in an overview of the prospective spatial differences in climate change effects in Hungary.

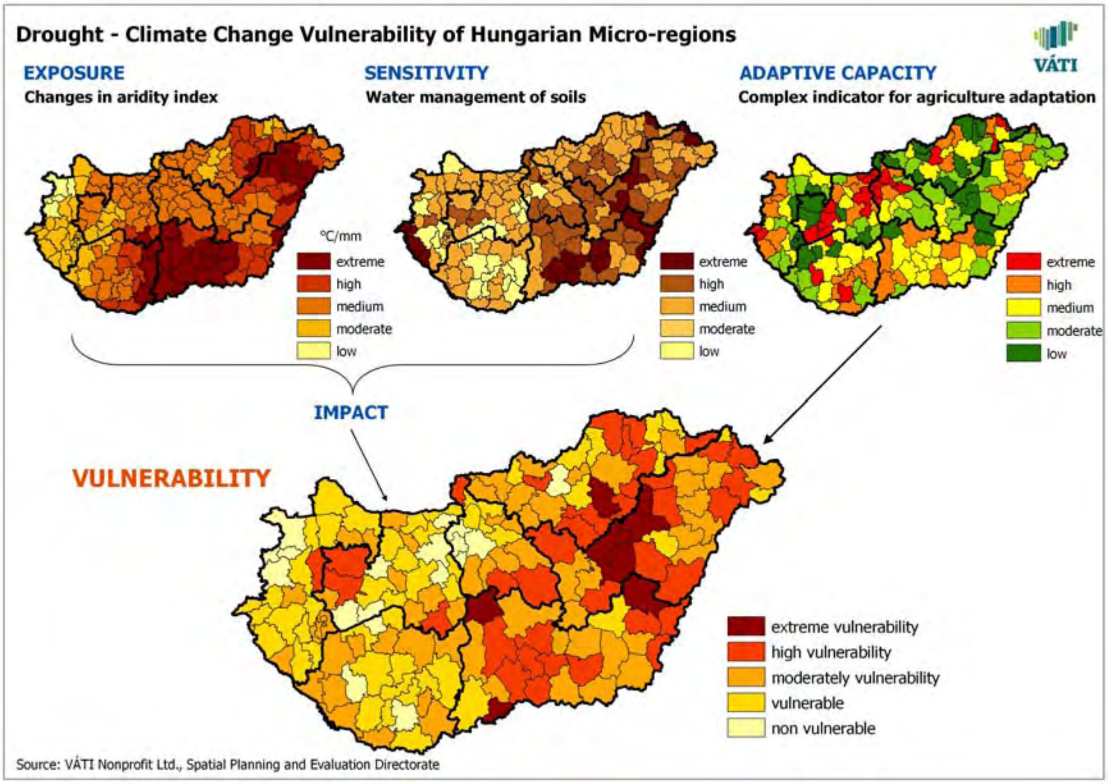


Figure 2: Vulnerability of Hungarian micro-regions related to drought (Source: The 4-Year Development Program to Prevent the Adverse Effects of Climate Change 2010-2013, VÁTI 2009)

European Environment Agency (EEA) has an important role in supporting data collection and management from different sources related to environmental processes and problems. With the help of this diverse database, European countries and organisations can make assessments and models of their own questions. Also, the Agency helps the Member Countries providing a decent background for creating policies on the adaptation to climate change. Overall, EEA is the main scientific institution in Europe that issues researches about climate change.

2. CLIMATE-FRIENDLY URBAN GOVERNANCE FOR FORMING ECONOMIC AND OTHER URBAN POLICIES

The concept of an urban climate policy – a policy that deals with climate protection and adaptation to climate change – and its governance issues can look back at a much shorter history than other urban policy related activities such as, for example, environmental and urban development policies. As a result, clear-cut, fully-fledged urban climate policy systems have not yet emerged almost anywhere. In fact, this is an ongoing process. Currently cities enjoy a great degree of freedom in shaping their climate policies and climate policy related partnerships. For example, they can freely decide what messages they adopt and/or adjust to their own specificities, and from what sources – these may be either the climate plans of any national, regional, or international organisation, or those of a partner city. However, too much freedom can cause vagueness. With this manual, we would like to help make these governance and policy forming choices easier and thereby to contribute to the shaping of a common European urban climate policy.

2.1. THE SYSTEMS OF THE EUROPEAN URBAN CLIMATE POLICY

Despite its short, a decade-and-a-half history, urban climate planning has become by now more than an activity carried out by various cities in isolation. In fact, it takes the shape of formal or informal systems. The top-down approaches start out generally from the national level and require cities to perform a number of climate planning related mandatory obligations. The system may also be built in a bottom-up approach, when the individual cities or groups of cities join forces in implementing their respective initiatives; they may go as far as elaborating international recommendations within the framework of regional, national, or cross-border co-operation schemes.

2.1.1. Building bottom-up and top-down simultaneously

A future European urban climate policy must be built by blending bottom-up and top-down approaches.

On the one hand, it is important to strengthen the community of climate-friendly cities and to develop further the existing European networks of climate-friendly cities that already have many members and significant achievements. This way, cities and their networks are empowered to initiate national and European regulation and policy intervention as well as the elaboration of co-operation schemes for sharing technical and methodological knowledge.

At the same time, urban climate policy frameworks must also be created both at the national and the European levels, for which the following need to be done:

- monitoring the climate policies implemented by European cities and systematically publishing the messages of these city initiatives;
- ensuring that the messages of the international initiatives in climate policy and the related scientific and technical achievements reach each and every city;
- elaborating a regulatory framework in the field of urban climate policy that provides the individual towns and cities with support and guidance to shape their own climate policies while at the same time, defining a set of minimum climate policy expectations that each and every city must comply with;
- integrating instruments serving as incentives for cities to introduce climate-friendly initiatives into all specialised policies, including especially EU-level development policies and support policies. The best example for this is when funding for urban development is made conditional on the adoption of certain climate-friendly actions.

2.1.2. Applying an integrated approach to sustainability

The climate change problem has a central part in the conceptualisation of environmental integration and ecology, both linked to the idea of sustainability. When we try to prevent climate change or prepare for its effects, we are in fact moving towards sustainability. Any sound environmental integration or sustainability policy must include preparatory measures for climate protection and climate change. Urban climate policy is a policy with an integrating force, it requires close interaction and co-operation with other policy areas.

2.2. ‘CLIMATE PARTNERSHIP’: A RESPONSIBILITY SHARED BETWEEN SECTORS

All stakeholders and interested parties must inevitably be involved in shaping urban climate policy, as only initiatives accepted by all city actors can possibly result in a legitimate policy. During policy shaping, the first step in creating partnership is to identify the potential target groups and all stakeholders of the proposed development and regulations. As the next step, the city’s residents, enterprises, and non-governmental organisations must be addressed and informed about the situation of the urban climate and about the developments planned to improve it.

Any climate policy is a common endeavour – an endeavour to which the whole community of a city dedicates itself. Of all the interventions involved, some are beyond the responsibility of city leadership or city management. The city’s non-governmental organisations, local residential communities, and even enterprises may play a role and take on responsibility in implementation. Of course, this can only happen if the climate policy is widely known and accepted as a result of public consensus achieved during the initial shaping of such policy, and if stakeholders have assumed due responsibly in implementation. These in turn, require genuine partnership and co-operation from the very beginning.

In an ideal scenario, even the very first decision – namely: *Is there a need for a climate policy?* – should be approached in a partnership, which then is also sustained during the formulation of the initial concepts and basic ideas. Hence partnership will not be restricted to merely commenting on the political intentions already expressed in basic documents.

The possible partners in shaping an urban climate policy include especially the following important groups:
- industrial firms (e.g. in reducing emissions);
- commercial enterprises (e.g. in decreasing emissions in transportation and in reducing the need for transportation by increasing the proportion of local products);
- service providers (e.g. climate-friendly or air-conditioned service spaces; climate alarm co-operation);
- employers (e.g. climate comfort solutions; climate alarm co-operation);
- research and development institutions and institutions of education (e.g. urban climate research; forecasting; information dissemination services);

- communities of homeowners and apartment block communities (e.g. climate comfort solutions, energy consumption);
- organisations of the elderly and of persons with health-related problems;
- local and national/regional non-governmental organisations (e.g. undertakings related to emissions, and the endeavours by employers and service providers);
- municipal institutions and services (water and energy supply, waste management, local transport, health, and rescue management).

An aim is to ensure that the stakeholders involved in the partnership are as representative of the city community as possible. This is the key to ensuring that all local actors assume common responsibilities. An additional important factor in forging appropriate partnership in the city is the involvement of various actors from neighbouring regions and settlements.

Any forum organised to engage actors, on the one hand, has to facilitate the dissemination of information, and on the other hand, should provide space for dialogue. It is the responsibility of the parties preparing the plans to find the most efficient ways to promote co-operation and involvement (these may include, among other things, hearings, campaigns organised by individual city districts, Internet sites and forums, electronic newsletters, etc.), the suitability of which vary across the various target and age groups. (It is important to note that while the elderly urban population, who are especially at risk in the context of climate change, are a key target group in climate planning, they are also a group that enjoys only limited access to some of the currently most popular electronic channels of communication.)

Creating a partnership is useful not only in the context of episodic policy shaping or planning actions. It is favourable to permanently maintain, institutionalise, and continuously expand such partnership. Doing so facilitates the easy involvement of the partners into the highest possible number of planning and political decision making processes.

London Climate Change Partnership

The London Climate Change Partnership consists of 30 member organisations, but involves a large number of further organisations in its activities, whereby the overall number of participants is in excess of 200. The members include local, regional, and national government agencies, several non-governmental organisations, and even market players and their associations (such as, for example, an association of insurance companies).

The most exemplary aspect of this initiative is that it is a permanent and institutionalised co-operation that has its own management group with the ability to support several planning processes. Obviously, one of the main objectives of the partnership is to support the shaping of London's climate change adaptation strategies. However, the partnership also participates in other city planning processes as well, including some of the most important ones such as the London Plan (London's spatial structure development plan). The group places special emphasis on facilitating information exchange and on sharing best practices and experiences.

Contact:
Web: www.london.gov.uk/lccp

2.3. WHAT CAN WE DO AT LOCAL LEVEL GOVERNANCE?

Cities can apply various governance approaches to implement their climate change policies. The cities' competency in selecting the proper elements of their climate governance is determined by their legal status in the state administration. However, there is always an opportunity for creative actions.

A sound urban climate change policy can be formed via the following fields of urban governance:

1. Converting institutions run by the city in an effort to reduce climate change by:
   - improving energy efficiency, and by;
   - using renewable energy sources.
2. Elaborating corporate climate-friendly policies for the enterprises supervised by the city (such as public service providers and city development agencies) and integrating such policies mutually with one another and with the city's own urban climate policy (e.g. energy supply, public transportation, waste management, public sanitation).
3. Encouraging and supporting the climate change mitigation efforts of the local population and economic actors
   - by disseminating information on climate change processes and their potential local effects;
   - by providing financial support for climate-friendly investments;
   - by providing consulting services in preparation for climate protection activities and disaster situations;
   - by creating a permanent partnership, by organising a climate-friendly community, and by building networks.
4. Strategic planning opportunities available to the city management with a view to climate protection (the integration of the city's climate strategies and/or climate protection concepts into other strategies of the city).
5. Regulatory tools available to city management with a view to climate protection:
   - urban structure plans serving aims of climate protection (e.g. the proportion of built-in areas and green areas);
   - building regulations contributing to climate protection (e.g. architectural design principles);
   - transportation regulation and transportation management activities of the city management with a view to climate protection (e.g. restricting individual motor vehicle traffic and giving preference to public transportation);
   - incorporating climate protection considerations into the system of local taxes (e.g. tax reductions as an incentive for curbing emission or special taxes on development projects in city districts where public transportation is insufficient);
   - regulating public utilities (water, waste, energy, public lighting) and consumption; applying climate-friendly incentives (e.g. for selective waste collection and saving water) and restrictions (e.g. on night-time lighting and on advertisement-related lighting);
   - introducing climate protection criteria into public procurement procedures at the level of the municipal government.
6. Climate-aware local economic policy: green economy and increasing regional self-reliance in production.
7. Organising the institutions of city management and city-level decision making in a climate-aware manner.
8. Also: even a city can act up to improve global climate justice.

An OECD Working Paper ('Cities, Climate Change and Multilevel Governance' ©OECD [CORFEE-MORLOT et al., 2009]) defines four modes of urban governance to implement climate change policies (according to the regulatory modes or urban governance):

- **Self-governing: the municipality as consumer.** Sub-national governments can limit their own consumption and ecological footprint through municipal operations management, including such efforts as promoting the energy efficiency of municipal buildings and the greening of public transport vehicles. This is the most widespread form of local action, driven in many cases by the direct financial benefits of energy savings.
- **Governing through enabling: the municipality as a facilitator.** The municipality can facilitate coordination with private and community actors, such as by establishing public-private partnerships for the provision of services and infrastructure. For instance, […] the municipal energy plan of the City Council of Venice […] includes a series of intention protocols involving a number of joint venture projects between private companies, municipal transport companies, housing administrators' associations and associations of planners, architects and engineers.

- **Governing by provision: the municipality as provider**. Governing by provision is accomplished through the use of material and infrastructural means in the provision of direct services (water, electricity, public housing etc.). By influencing infrastructure development and service delivery, local governments can modify public consumption and waste disposal patterns. A local or regional government can thus impact local climate change action as the majority shareholder in the local utility companies for utilities and other public goods in the field of energy, transport, water and waste services. However, this potential for influencing the supply side of energy has been considerably eroded by the deregulation of energy markets and the privatisation of public utilities may have changed ownership structures and the policy levers for local authorities to intervene in this area.
- **Governing by authority: the municipality as regulator.** Local governments may enact regulations to curb CO_2 emissions if they have legal jurisdiction over relevant policy areas such as energy, transport, land use and waste. Examples include Barcelona's solar thermal ordinance; […] and restrictions on the use of cars in Munich and Paris. The extent of such a mode of authoritative governance, however, is closely linked with the municipal regulatory mandate in areas related to climate change, which in turn is determined by national law and regulation. Depending on the political system, states, prefectures, and provinces may have considerable autonomy in establishing climate change targets, renewable energy and energy efficiency strategies, transportation planning, and regional development schemes or regulations in the relevant areas. Even with a strong mandate, however, identifying public financing to leverage private investment locally may ultimately constrain or enable effective action.

The more integrated a city's climate policy is – the more it pervades city governance – the stronger it is. It is therefore reasonable to propose that cities take climate-friendly steps in as many areas of governance as it is possible.

2.4. MULTILEVEL GOVERNANCE

The climate change related – and, more generally, sustainability related – tasks of cities cannot be suspended by the city borders. Larger cities and their wider surroundings inevitably form closely interrelated systems through their increasingly intensive socio-economic and environmental interrelations. Within such a system, in addition to transport links and commuting, the city also relies ecologically on its rural and natural environment, while the dependence of rural areas on their urban centres is something quite obvious.

Accordingly, issues and their interrelations do not emerge strictly within administrative boundaries, and they can hardly be tackled in a framework restricted by those administrative boundaries. It is therefore of utmost importance that the legitimate actors at the various levels – the settlements and regions concerned as well as the 'owners' of specialised policies – share efforts in tackling climate change mitigation and adaptation tasks of the city and its wider rural environment.

In addition to the municipal governments of settlements that coexist in a functional whole (at the level of urban region and/or agglomeration), and besides regional authorities, the national level also plays a influential role in how successful the creation of sustainable structures will be within the urban regions (e.g. through environmental transportation, regional development policies, and even through tax policy defined at the national level). At the same time – in addition to the administrative authorities – citizens, economic and market players, as well as their communities and networks also play a key role. Accordingly, creating and maintaining appropriate, transparent, and continuous partnership with the various non-governmental organisations and market actors is of key importance.

At the very same time, this governance approach relies not only on partnership but also on strategic planning, where flexibility and a proactive approach rather than a bureaucratic attitude are crucial. Promoting the multilevel governance approach is therefore of utmost importance in tackling and mitigating climate change at the level of cities and urban regions. Chapter 4 *'Climate-friendly urban structure'* will detail the challenges related to rural areas around cities as well as the possible solutions, with a special emphasis on the urban sprawl phenomenon, how it can be managed, and what planning tasks arise.

2.4.1. Governance co-operation between cities and regional/national levels

Urban climate change policy needs the following types of governance co-operation between cities and other levels of territorial administration (OECD, 2009):

– **Regionally coordinated actions:** Co-operation between the regional and the city levels leads to climate policies that mutually strengthen one another. Co-operation makes it possible to up- and downscale climate change related issues in order to select a proper set of multilevel actions. Thus, for example, a successful energy initiative of a city may become a regional standard. In turn, a climate-aware regional disaster management plan can, on the one hand, harmonise the flood protection plans of the individual cities (pointing out where buildings should not be located even if they would be otherwise highly energy-efficient), and, on the other hand, it may serve as the basis for elaborating the site-specific details of the cities' flood protection plans (such as, for example, exploiting and depositing materials required for flood protection operations).
– **National and European level mainstreaming:** The co-operation between the national level policy forming bodies and the cities supports the mainstreaming of the cities' progressive climate change initiatives into the national climate policy, and even into other relevant policies, such as transport, health, education, water management. It also means that regional and national climate protection and adaptation actions should not merely be organised around large projects or flagship initiatives (such as, for example, a power plant conversion programme, a river regulation project, etc.), as these do not offer a chance for bottom-up city initiatives or to the emergence of solutions tailored to the local conditions.

The co-operation between the cities and higher levels need well organised mechanisms and a strong vertical partnership in planning and policy forming.

MODEL project for the support of local authorities in rational energy use

MODEL (Management of Domains Related to Energy in Local Authorities) is a programme to reduce the energy gap in the European Union and beyond. It encourages volunteer municipalities to become models for their citizens, other municipalities and local stakeholders in the field of rational use of energy. It was launched in 2007 with the support of the Intelligent Energy Europe programme.

The objectives of the project were:

– assisting its pilot cities to plan, implement and evaluate a full set of activities meant to improve local energy efficiency, focusing on their overall process management; and
– improving their practical capacities in the field of energy efficiency and communication with their citizens on this issue.

To achieve this goal, MODEL was organised to act at 3 different levels:

– European level: Energy Cities, EnEffect and the 8 MODEL national partners were involved in a constant process of exchange of experience, EU added value, common training and events, coordination, etc.
– National level: the 8 MODEL national coordinators organised various activities to support the pilot cities and promote the MODEL common framework methodology towards several other municipalities: training, promotion, information, technical assistance, etc.
– Local level: thanks to the MODEL support, the pilot cities developed their human skills, technical capacities and communication activities and implemented a full set of practical activities including ones to raise awareness among their citizens.

43 pilot cities from 10 new EU member states and Croatia decided to join the project. The 43 pilot cities represent over 2 million citizens. The authorities have taken the next concrete steps in the field of energy saving:
– appointing municipal energy managers;
– organising an energy unit within their administration;
– developing a local energy action plan and energy information systems;
– looking for funding for concrete investments;
– improving the communication of energy issues towards citizens.

For the future, the MODEL project is now addressing 6 new pilot cities from Armenia, Georgia, Moldova and Ukraine.

Contact:
Web: www.energymodel.eu
Project coordinator: www.energy-cities.eu
Phone: +33 3 81 65 36 80

Investment Programmes in Sweden: Stimulating local initiatives for an ecologically sustainable society (source: www.naturvardsverket.se)

In 1996, to promote the transition to an ecologically sustainable society in Swedish municipalities, the government decided to start funding Local Investment Programmes (LIP). In 2002, Local Investment Programmes were replaced by Climate Investment Programmes (Klimp), more specifically aiming at reducing the emissions of greenhouse gases.

The Swedish government's support to Climate Investment Programmes is a tool for reaching the Swedish climate objective as formulated in the Swedish Climate Strategy in 2002. Klimp has enabled municipalities to receive grants for long-term investments addressing the reduction of greenhouse gas emissions. Klimp is contributing to achieving the climate objective in three ways. The investments lead to reduced emissions of greenhouse gases. The work on a climate investment programme strengthens local climate work and co-operation between various actors, and by means of collecting and disseminating knowledge and experience of climate investments, encourages climate work in other parts of the country.
In order to achieve its aims, the Klimp initiative takes a holistic view into consideration and the investments are made in the sectors that have the largest impact on climate. This applies measures in the transport and energy sectors, but they focus on the results, not on certain technologies. They include expansion of district heating, transition to biofuels, measures to boost energy efficiency and local information about the climate related issues and the ongoing projects. Almost one third of the Klimp grants have been invested in biogas measures.
Applying a bottom-up approach, local authorities have been required to make priorities based on their local condition and local policy. Only the best measures in the best climate investment programmes have received funding which means approximately 25% of the total budget of each programme. The programmes have been awarded points depending on how well they demonstrate good climate strategies, overall perspectives, collaboration, efficient use of funding and environmental effects. The competition has facilitated the co-operation between the local actors, while giving priority to sustainability issues. The results of the Klimp initiative are showcased by the website of Green Investments in Sweden (MIR), where detailed information can be found on the projects within the LIP and Klimp programmes.

Between 2003 and 2008, Klimp funding of SEK 1.8 billion was granted for 126 climate investment programmes. Together, the programmes comprise about 900 measures and an investment volume of just over SEK 8 billion. The grants have been distributed five times by the Swedish Environmental Protection Agency between 2003 and 2008. The outcomes of the investments are: the reduction of up to 2 million tons of carbon dioxide per year (the total greenhouse gas emissions in Sweden were almost 64 million tons in 2008); saving of 3.3 TWh of energy per year and conversion of 3.2 TWh of fossil energy by renewable energy (the total energy use in Sweden was 397 TWh in 2008).; reduction of waste to deposit by 460,000 tons per year.
Between 2008 and 2010 a new programme was launched aiming at contributing towards creating attractive, ecologically, socially and economically sustainable urban environments that can serve as models for integrated sustainable town planning and applied environmental technology and disseminate knowledge of such urban environments. The government has appointed the Delegation for Sustainable Cities with the role of managing and awarding the financial support for the development of sustainable cities. This support is intended to stimulate urban development projects that help to reduce emissions of greenhouse gases. Support can be

provided for investment projects that preferably relate to new construction or reconstruction in an urban district, residential area or block and relate to energy, water, waste or transport. The support is also intended for planning projects, i.e. measures for example in the form of feasibility studies, programme writing, cross-sectoral planning and information measures or efforts. The total level of support for the period 2009-2010 was SEK 340 million.

Further information can be available at www.hallbarastader.gov.se

Finnish municipalities for the handling of climate change

AFLRA is an umbrella organisation of cities and municipalities aiming to promote opportunities for local authorities to co-operate in order to enhance their vitality for the benefit of the residents.

In 2010 the ALFRA adopted guidelines with recommendations on how to handle climate change at the local level adjusting to the National Energy and Climate Strategy of 2008. Part of the municipalities has already initiated campaigns to encourage the citizens to contribute to combating climate change. In the local government climate campaign, there are 45 municipalities, representing more than one half of the Finnish population. In addition to that, climate strategies have been worked out in 71 municipalities out of what 42 municipalities have already completed them. These municipalities represent almost three out of four Finns.

During the recent years, there has been a growing interest in the role of local actors in the implementation of climate policy. In Finland, this interest has resulted in several projects on various climate activities at the local level. In the following, there are brief presentations of two nationwide networks that involved local governments in Finland in an active role in combating climate change.

Since 1997, there has been a national campaign named Cities for Climate Protection. The ALFRA has been the co-ordinator of the network offering its members a variety of meetings, seminars and conferences. Since 1997, five municipal climate conferences have been held. These conferences provided opportunity for municipalities to share experience and best practices with colleagues from other parts of the country. Up until this time, 46 municipalities have joined the network.

Another project is called the Climate Change and Municipalities' Decision-Making. It runs from 2009 to 2011. The project is led by the ALFRA – and three ministries (Ministry of Environment, Ministry of Employment and Economy and the Ministry of Transport and Communications) finance the project. The aim of the project is to improve municipalities' ability to make climate-related decisions which are also economically correct and support the overall development of the municipalities. Under the project, a number of meetings, seminars and experience and best practice sharing take place. A large number of municipalities/regions are involved in the project (in total 34 municipalities).

Reference Framework for Sustainable Cities (RFSC) – A toolkit for the integrated approach

In May 2007 the European Ministers responsible for urban development signed the 'Leipzig Charter on Sustainable European Cities' with the aim of improving the policy setting for integrated urban development, with a particular focus on deprived areas. In November 2008 they called for the implementation of the Charter in the Marseille Statement. As a result France and the French Ministry of Ecology, Energy and Sustainable Development set up a high level European working group to develop – with and for the cities – a reference framework for the European sustainable cities. They also wished to increase the focus on climate change in recognition of its rising importance. This working group – including the EU Member States, European institutions, and European organisations representing cities and local governments – has developed a set of tools during the years 2009-2010 that could support local authorities and different stakeholders in making decisions aligned with their urban strategy, policies and plans. In 2010, in Toledo, the European Ministers responsible for urban development confirmed their wish that the reference framework should be disseminated and that its testing phase should be implemented by European cities.

The Reference Framework is an on-line toolkit to assist actors of urban management and development to improve dialogue and actions on sustainability. The aim is also to encourage local authorities to develop their own measures or actions, which best suit them and which are possibly not fully reflected in the Reference

Framework. In doing so the tool is structured in the following way:
- questions and tools aiming at helping to characterise the current situation of the city and identify its main information and key urban development issues;
- questions and tools supporting the adaptation of an integrated urban development approach;
- a set of suggested indicators and visualisation tools in order to monitor the progress of the territory;
- relevant documentation with direct access to European or national reference texts, city illustrations and other interesting documents related to the European sustainable city;
- the basis for a common platform of dialogue between European local authorities and professionals, linked with other networks.

Following the testing phase with a wide range of European cities, the final version of the prototype and its entire operability are planned for the end of 2011, under the Polish presidency of the European Union. Its wide dissemination and communication will be scheduled for the first half of 2012, under the Danish Presidency of the European Union.
More information is available at www.rfsustainablecities.eu.

2.4.2. Networks of climate-friendly cities

Creating networks of climate-friendly cities is a well embedded governance form of the urban climate actions. The Annex of this Handbook includes additional material on such initiatives.
- Organised into networks, cities implementing similar climate policies can jointly present significant interventions to mitigate climate change (especially because the activities causing climate change are concentrated in cities).
- Networks organised based on a geographical principle facilitate more efficient preparation for climate change adaptation thanks to the harmonisation of protection efforts and the exchange of experience (e.g. the cities of a river valley can harmonise their flood protection strategies, while Mediterranean cities may exchange their experiences about shading techniques in public outdoor spaces).

Covenant of Mayors

The Covenant of Mayors is a bottom up initiative, a city network which aims at reducing CO_2 emission, and at increasing energy efficiency, clearer energy generation and consumption in accordance with the energy policy of the European Union. The signatories of the Covenant of Mayors are local authorities, which were 2357 on 24th March 2011.
The Sustainable Energy Action Plans (SEAP) sets out the specific reduction targets and defines the concrete measures that the local authorities will undertake to achieve it by 2020. The local authorities ensure the necessary human and financial resources to implement actions set out in their SEAPs.
The Covenant of Mayors is open to cities of all sizes in Europe. Those cities and towns which do not have sufficient resources to draft and implement their own action plan can be supported by administrations with such capacities. These supporting structures can be regions, counties, provinces, agglomerations, NUTS III areas, or mentor cities. The Supporting Structures are defined as those entities that are in a position to provide strategic guidance, technical and/or financial support to municipalities with the political will to sign up to the Covenant of Mayors, but lacking the skills and/or resources to fulfil its requirements, namely the preparation and implementation of Sustainable Energy Action Plan.
The EU Committee of the Regions stresses the need to combine the local and regional forces, as multilevel governance is an effective tool to enhance the efficiency of the actions to be taken against climate change. Therefore, the involvement of regions into the Covenant of Mayors are promoted.

EUROCITIES

EUROCITIES is a network of major European cities which bring together the local governments of more than 140 large cities in over 30 European countries. ‘EUROCITIES provides a platform for its member cities to share knowledge and ideas, to exchange experiences, to analyse common problems and develop innovative solutions, through a wide range of forums, working groups, projects, activities and events.’ One of the EUROCITIES’ policy priorities is to fight against climate change.

'EUROCITIES joins forces with other city networks in the 'Local Government Climate Roadmap' to work together for recognition of local governments' role and contribution in fighting climate change. This roadmap is a multiannual process closely following COP13 (Bali), COP14 (Poznan), COP15 (Copenhagen), COP16 (Cancun) and currently COP17 (Durban).' 'EUROCITIES plays an active role in several European initiatives like the Sustainable Energy Europe Campaign, Covenant of Mayors, COMMERCE, the European Mobility Week EPOMM-PLUS, CIVITAS Catalist and CIVITAS Guard'.
'In October 2008, EUROCITIES launched its 'Climate Change Declaration' […] The declaration testifies to their commitment towards ensuring that action is undertaken at the local level against climate change. Cities are best placed to speak with their citizens on global matters such as climate change, and to show how changes made at the local level in all areas of public life, from waste management, to public transport, to cultural events, among others, can contribute to facing this global challenge.'

Source: www.eurocities.eu

Furthermore, through their practice-oriented bottom-up initiatives, city networks have the power to shape national and international climate policy as a form of feedback. For this to happen, regional, national, and EU climate policy must ensure the following:
- openness in taking aboard initiatives arriving from the climate policy networks of cities;
- the participation of such networks in higher-level climate policy governance using institutionalised instruments.

2.4.3. Climate-friendly relations between cities and their regions

The inter-settlement co-operations organised at a lower geographic scale (at the level of microregions and regions) present additional peculiar dimensions of climate protection. These are typically co-operation schemes between cities and their immediate environments, or between metropolitan areas and their surroundings. The work performed together at this level offers practical opportunities for organising all areas of climate-friendly urban governance at the regional level. The following climate protection related aspects are especially suitable to be managed with a regional approach that looks beyond city limits in its perspective:
- Particularly the adaptation policies – planned and implemented typically at a regional level – need collaboration between the municipalities (for example, water management systems and precautionary flood protection measures along rivers). (OECD, 2009)
- Mitigation policies also need collaboration, as they are frequently related to the technical infrastructure cutting city borders (e.g. power supply and transport, or see even some ideas and attempts related to regional emission quota trading between cities). (OECD, 2009)
- Organising public services and supply at the regional level: ensuring that public services and commercial retail are accessible by consuming the lowest possible amount of energy, e.g. by setting up local service points, by improving public transportation, and by facilitating e-access.
- Elaborating common standards for operating institutions, securing common climate-friendly energy supply, and implementing energy efficiency investments.
- Joint regional strategic planning and a joint visioning of the settlements' structure, taking into account the urban and rural processes relevant in the region (such as, for example, the urban sprawl phenomenon or rural depopulation, respectively). Chapter 4 *'Climate-friendly urban structure'* will discuss additional aspects of settlement structure related to the rural environment of cities, with special emphasis on urban sprawl.
- Creating co-operations based on climate partnership of the economical actors and the civil society with a perspective beyond city limits, covering the entire region. (Note that production plants with large emission rates are often located outside city limits.)
- The local and regional climate-friendly economy and energy policies may be implemented in an approach that views the city and its rural environment as a single unified system. See detailed in Chapter 12 about economy policy.

2.5. HIGHLIGHTED GOVERNANCE ISSUES FOR MANAGING CLIMATE CHANGE

2.5.1. Supporting global climate justice at city level

European cities are given the option to balance the environmental damage they cause by supporting less affluent communities in the 'developing' world outside the EU. The environmental load generated by the population of the developed world, including the EU, is usually several times as high as that of the population of the developing world, primarily because of higher levels of consumption. However, the environmental load behind such higher level of consumption often hits developing communities harder and more directly than developed ones. (A typical example is tropical deforestation, where major climatic and other detrimental environmental consequences represent the cost of meeting the demands of mostly well-to-do societies for wood and food.) The adverse effects of climate change also often have the hardest impact on less well-to-do countries, as these countries have limited resources and can therefore prepare much less efficiently for preventing disasters (e.g. the costal cities of the developing world can do much less against the more and more frequent see floods than the European cities can do).

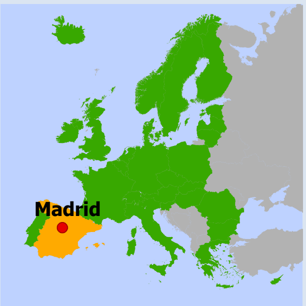
The technical and financial support offered by local communities in the developed world can help those in the developing world protect their natural environment, and to prepare for climate protection as well as for the adverse effects of climate change. It is also important to help the communities of these settlements or regions in ways which ensure that their development will not be solely dependent on the fluctuating demand and the changing consumption patterns of the developed world. Support and consultation may also help these areas avoid those development mistakes which had already been made in the wealthier part of the world (e.g. the introduction of resource-wasteful technologies, or the creation of a consumption society).

2.5.2. Climate-friendly public procurement

Climate-friendly public procurement is an instrument of climate policy that is closely related to both the city's economic policy and to regulation as a whole. Cities integrate their climate-friendly expectations into their public procurement calls for tender. In evaluating the proposals, they take into account the environmental load resulting from implementation as well as how and to what extent the given development project serves the purposes of local climate protection in the future.

The following possibilities are available in support of the above efforts:

– Calls for tender for technical and technological equipment can directly include climate protection requirements.
– A number of criteria may be used to screen applicant organisations based on, for example, whether they implement the required climate-friendly corporate policy. Alternatively, preference may be given to companies supporting climate-friendly initiatives.
– An additional, indirect way to enforce the above ideals is for the municipal government to encourage the participation of those enterprises that are either locally based or rely on local resources. This maintains the sustainability principle that local communities and/or local enterprises should primarily rely on local resources, and, conversely, local resources should be primarily utilised by local communities and/or local enterprises. For instance, the transportation needs and its harmful effects on the climate can be reduced this way.



Madrid, public procurement for environmentally friendly transportation

The Spanish capital, Madrid has a population of over 3.9 million people, its metropolitan area included.

In 2008 the City Council of Madrid decided to implement two plans in order to reduce air pollution. One of the plans received the name 'Green Fleet'. As part of this project, the municipal government started replacing its own public service vehicles (buses and waste collection trucks) with motor vehicles propelled by alternative energy sources instead of fossil fuels. By 2011 the city's plans foresee the complete shift over to alternative vehicles that are either greener or are fully environmentally friendly. The other plan targets the corporate sector. So far the city has succeeded in convincing 35 major corporations to support the cause. These companies can network and exchange their experiences at 'Foro Pro-clima Madrid', the Madrid Climate Protection Forum. Each and every member of the Forum has accepted that by 2012 at least 6% of the motor vehicles in their corporate fleets will be propelled by clean fuels.

Today, as many as 1,800 vehicles of the municipal government are either certified as Category 'A', a rating that reflects their top-notch energy efficiency, or they run on alternative fuels. 41 vehicles run on bioethanol; this small fleet of vehicles alone saves as much as 104 tons in CO_2 emission. The municipal government acquired its bioethanol vehicles through BEST, an action of the EU's Sixth Framework Programme designed to promote the wider use of bioethanol as a fuel The city's costs related to the BEST project amounted to one million EUR; 50% of this was financed by the EU.

Contact information:
Javier Rubio de Urquia, Madrid City Council
E-mail: rubiofj@muninmadrid.es
Web: www.munimadrid.es

2.5.3. Building a climate-aware institutional system

Another important governance related issue is the institutionalisation of urban climate policy. The best proposal for managing climate policy is an integrated, project-oriented institutional structure instead of the traditional city management structures that rely on sector-oriented organisational units. This is the best way to ensure that urban climate plans are implemented with the participation of all stakeholders and responsible parties within the city management structure. A city's climate change organisation cannot possibly be tied to a single institution or organisational unit because of the wide-ranging sectoral linkages the issue has. In a favourable situation, this work is implemented through the institutionalised co-operation of the organisational units (e.g. joint committees and working groups). Creating such co-operation between the city's political leadership and the organisational units of its management is also most valuable.

An OECD working paper ('Cities, Climate Change and Multilevel Governance' ©OECD [OECD – CORFEE-MORLOT et al., 2009]) introduces the integrated institutional model of the City of Zurich for urban climate policy. The city established a unit for environmental protection in charge of supervising the city's climate policy with cross-departmental tasks within the city administration. This unit is responsible for assessing every planned development and construction project in terms of their impacts and the departments responsible for the implementation of these developments need to account for the results of this assessment. To guarantee that this model works properly requires, first, strategic plans comprising sectoral targets, policies and measures (such as the combination of a general master plan for the environment and a specific master plan for energy in the city of Zurich); and, second, a project-based approach which prevents departmental segregation.

2.5.4. The city's economic policy: green economy (green growth) and local economic development

The local and regional economic policies implemented by cities or jointly shaped by cities and their regions offer unique climate protection opportunities. A city's economic policy is one of the most important areas of competency in urban governance – one that requires the harmonisation of several sectoral activities. (See detailed in Chapter 12 about economy policy.)

BRIEF RECOMMENDATIONS

- It is imperative to ensure that the climate policy initiatives of cities and networks of cities are widely known both at the European and national levels, and to integrate the experiences they accumulate.
- The more areas of competence in city governance they rely on, the stronger urban climate policies can be. Climate-friendly ideas may be integrated at every stage from regulation and disseminating information among the population and the economic actors, through designing incentives, and all the way through to the operation of public services.
- A city's climate policy requires multilevel governance co-operation. Accordingly, the actors of governance outside the city must be involved in shaping the policy. These include, for example, the following:
  - the largest possible number of settlements within the geographical landscape (e.g. river valley) wherein the city is located;
  - the city's catchment area, including the rural settlements therein;
  - the members of the city network co-operation set up for climate policy; and
  - the relevant regional and national agencies, even if these levels do not yet have any elaborated climate policy of their own.
- The owner of an urban climate policy is not the city management but the entire city community. Accordingly, urban climate policy must be shaped within the framework of a widely based, permanent, and well organised partnership that integrates both the residents and the economic actors of the city.
- European cities shall feel responsibility towards global climate change mitigation and adaptation efforts, and shall find the way of supporting the climate actions of the cities and organisations in the less developed countries.
- Applying green public procurement, building integrative institutions for managing climate change, and greening the urban policies on economic development are the main fields of climate-aware urban governance.

3. INTEGRATED STRATEGIC PLANNING FOR CLIMATE-FRIENDLY CITIES

Urban environments are extremely sensitive to the effects of climate change, while the cities themselves are principal contributors to climate change. Adverse effects may be reduced and the urban climate may be significantly improved by integrated and complex urban strategic planning. As a result, in developing urban areas, the type of urban planning that needs to gain prominence is one that takes into account both the peculiarities of the urban environment and the diverse impacts of climate change. This may be implemented effectively through the harmonisation of the individual sectoral plans and development concepts, and through mainstreaming the concept of sustainability.

The fact that the phenomenon of climate change is widely known, the large number of people it affects, and the imminent threat of its consequences are three very good reasons for cities to engage in strategic climate planning.

Urban climate planning can take the form of an independent planning procedure or it can form part of other city-level planning processes (such as, for example, energetics or environmental planning). Regardless of its form, urban climate planning must always apply an integrated approach. When working on climate planning, it is a good idea to adopt the integrated methodology used in environmental/sustainability planning and evaluation.

This chapter offers an overview of the planning and methodological possibilities of climate change integration for those experts familiar with the systematic strategic planning, programming, and evaluation practices that the European Union itself follows, among others. Interpreting the messages of this chapter may require a degree of background knowledge.

All over Europe, a range of widely diverse urban planning systems have emerged. Because of the differences in both regulation and actual practice from one country to another, it is impossible to elaborate concrete planning guidelines that each and every European actor can apply. For this very reason, the focus of the following paragraphs will be restricted to the possible principles and tools of climate planning integration.

3.1. CONSTRAINTS OF MULTI-DIMENSIONAL INTEGRATION IN URBAN CLIMATE PLANNING

In today's planning practices, using an integrated approach is a basic expectation. Both urban planning and climate change offer an especially wide range of opportunities to rely on various modes of integration:

– **The climate-friendly city as an ideal testing ground for the integration of ecotechnologies and developing green infrastructure**
  Urban development offers an excellent ground for integrated climate-friendly development and operation of the various infrastructure systems and technologies serving housing needs. The

reason for this is the specific urban context which combines production capacities and consumer demand in close vicinity of one another and offers highly varied natural and environmental conditions, while transportation needs are limited to relatively short distances. All this results in the fact that the products, emissions, or, as the case may be, waste materials of any given sectoral activity (especially agriculture, landscaping, water management, waste water treatment, solid waste management, transportation, and heating) can easily be utilised as a source of energy or raw material for another local activity. Technological integration schemes can thus serve the basic principle of preventive climate protection and climate adaptation efforts: energy saving, reducing the production of waste heat, curbing air, water, and soil pollution, and creating the healthiest possible urban ecosystems. An added significant advantage of climate-friendly technological innovation is the fact that it is not only climate-friendly, but it also supports sustainable development and environmental integration, as its technical solutions rely primarily on renewable energy sources and serve green economic activities.

In addition to technological integration, planning the urban infrastructure in a proactive, integrated approach and developing green infrastructure bring further significant climate advantages and sustainability performance (some examples could be internal spaces of ample size and quality, a street structure guaranteeing ample cross-ventilation, etc.; the following main chapters will present a wide range of solutions).

- **The city and climate change: multiple pressures towards integration**
  - **The city as a classic site of integrated management**

    Urban centres are where economic and social actors, decision makers, the managements of the individual economic sectors, and the institutions of the public sector concentrate. Harmonising and integrating the varied interests and visions they represent is in itself a major challenge.
  - **Climate change as an inevitably integrating global force**

    In our age, when more and more problems, symptoms of crisis, and, of course, opportunities are increasingly global in nature, one of the typical functions of urban planning is to look for local responses to global challenges. However, no thorough answers can possibly be identified just by looking at global challenges in isolation. Moreover, such a challenge is an integrated phenomenon even in itself with economic, social, and environmental aspects alike, whose treatment requires complex intervention.

    The topic of this volume – climate change – is closely linked to phenomena as diverse as floods directly threatening human lives, a downturn in agricultural production, the pressing need to rethink construction activities, and even massive public sanitation crises. It is therefore possibly the best example of the complexity described above. Climate change related issues must therefore be inevitably considered in an integrated approach. In turn, the complex world of cities calls for even more deeply integrated adaptation measures and preventive urban climate strategies.
  - **The city and climate: models of sectoral integration applying a regional approach**

    The territorial structures of towns and cities are diverse; different urban districts are characterised by different weaknesses and opportunities. Accordingly, urban planning must be territorial and regionally integrated in its approach. On the one hand, any given sectoral intervention must be designed differently for each city district, adjusting it to the local conditions. On the other hand, the various sectoral interventions applied within the same city district must be coordinated among themselves.

    Another important feature of climate change phenomena is that they appear in widely different forms from region to region. This is especially true when it comes to urban climate, because a relatively small-sized urban area can show widely varying physical and natural characteristics. Identifying and tackling these diverse challenges therefore requires a sound territorial approach and integration.

– **Integration in planning: the approach to be followed in climate planning**
  When planning urban climate strategies, both objectives and interventions must be embedded into the economic and social structure of the cities and must be adjusted to their geographic characteristics. It is therefore reasonable to design these climate strategies not as separate plans in their own right but either as part of other fundamental urban development planning documents of adequate legitimacy or as plans prepared in close integration with those standard plans.

3.2. OVERALL URBAN CLIMATE OBJECTIVES AND PRINCIPLES

Climate protection objectives and principles have gained in popularity over the past several years. Promoting these is made easier by putting climate protection thinking into the wider context of environmental integration and sustainability efforts. If a city is climate-aware and wishes to act in order to protect the climate, it also inevitably integrates environmental objectives and promotes sustainability. The reverse is also true: a sustainable city always performs well in terms of climate protection. Therefore when preparing urban climate plans, many well-known environmental and sustainability related objectives and principles can be applied, most of them being easy to adapt to the more specialised climate context. Of course, there are additional, unique objectives beyond these that are only meaningful in the narrower context of urban climate protection.

Preventing climate change in towns and cities: possibilities on a global scale and in local urban spaces (mitigation)
In the case of cities, mitigation offers unique opportunities. A significant proportion of carbon dioxide and other GHG emissions and the activities generating those emissions, which in turn are responsible for climate change, are either concentrated in cities or serve to meet the demands of cities. Accordingly, any efforts that cities take can be significant in helping mitigate global climate change. However, the typical backdrop for urban mitigation efforts is not the global dimension. Cities and towns have their own characteristic local climate that is prone to change along with global climate. Reducing the environmental load generated by urban activities does not only help in a timescale of several decades and on a global scale, which is what otherwise normally happens. In many cases, these actions can lead to noticeable changes within the city and its environment in a matter of just months. This offers unique opportunities for presenting spectacular success stories thanks to which it becomes much easier to involve citizens, institutions, and enterprises and convert them into active stakeholders.

Preventing climate change in towns and cities using the tools of regional sustainability
The increase in the environmental load that leads to climate change is mostly driven by increasing consumption and rising demand for mobility. A city and its region offer excellent opportunities to mitigate both. If a city and its environment form a unified urban-rural space, a whole range of opportunities opens up to reduce their dependence on global processes to optimum levels. Organising urban markets can re-establish the unified system of products and services that the co-operating rural and urban areas can mutually offer to one another. Stimulating local production and service relationships help curbing reliance on external resources, reducing the need for transporting them and thereby decreasing the environmental load involved in transportation and travelling.
The sustainability of a region is also served by the efforts to involve more efficient technological solutions into construction, production, or transportation that rely either on less energy consumption or on renewable energy sources.
Changing the consumer’s mentality by raising awareness of sustainability is also a climate-friendly measure. A decrease in consumer demand for new products that involve high energy consumption, the increase in product life cycles and reusability, or a rise in demand for energy efficient and climate-friendly products and services are examples for this.
Special climate protection tools to prepare towns and cities for climate change (adaptation)
Adapting to climate change should be at least as important an intention in urban climate planning as prevention. Adaptation is often relegated to a subordinated role in the climate policies of cities.

Several factors explain this. On the one hand, research and regulatory frameworks related to prevention go back to quite a history and are fairly advanced when compared to adaptation. As a result, the specific effect of climate change on any given city and the appropriate ways to adapt to those effects most often require additional separate analysis even before the climate planning process begins. (Of course, this requires more resources for planning, something that is often out of the question.) Adaptation may also be pushed into the background by the fact that the proposed means of adaptation often seem to be at odds with prevention (e.g. when the only proposed measure to adapt to ever more frequent heat-waves is installing additional air-conditioners).

The adaptation opportunities available to cities are different from the mitigation objectives feeding on general environmental considerations: many adaptation interventions can only be justified in the context of climate protection without direct environmental concerns (such as, for example, protection against strong solar radiation or ensuring thermal comfort). Separate climate protection objectives may be defined for each segment of city management and urban development; this manual offers detailed information in this respect. In particular those specialists who are responsible for shaping the urban structure, construction regulation, housing policy, organising public transportation, and disaster management cannot ignore adapting urban climate protection objectives to their respective areas.

The climate change adaptation objectives of cities can fulfil two fundamental functions regardless the area of specialty concerned. (1) Objectives related to tackling regular or permanent weather phenomena implied by climate change and often intensified by the urban climate (such as, for example, the climate regulation of indoors spaces). (2) Objectives linked to the management of episodic disaster situations (which may be natural, technical, or public sanitation and health related) which are caused by extreme weather events becoming increasingly frequent as a result of climate change (these are of special importance because they threaten many human lives and valuable assets in urban areas and because they call for specialised solutions due to the peculiarities of the urban setting). This manual discusses both groups of urban climate protection objectives in detail.

3.3. THE TOOLS OF INTEGRATION IN CLIMATE PLANNING

We have already demonstrated how both climate change and urban planning are issues that require an integrated approach equally touching on environmental, social, and economic structures. Both issues necessitate a regionally differentiated approach and interventions that encompass several economic sectors and are harmonised within each region. As a result, urban climate planning cannot do without an integrated approach either.

In the following paragraphs we expand on the fact that integration is not restricted to harmonising various themes and economic sectors; it actually means the integration of the planning processes themselves: formulating an urban climate strategy only makes sense if it takes the form of a planning document elaborated through processes that are fully and organically integrated into the city's own planning system.

3.3.1. The optimum levels of climate planning

Ambitious-sounding declarations of intent need to be supported by real climate-friendly development

Considering the fact that climate strategies can only be successful through harmonised interventions involving a wide range of actors and economic sectors, confining them into high-level policy documents (such as, for example, position statements, political declarations, guidelines) is just not sufficient. It is therefore reasonable to shape the climate planning process at planning levels where they formulate unambiguous messages not only about the objectives but also about the most important parameters of the actions (resources needed, scope and principles to follow, timetables to adhere to), about scopes of responsibility, and about the measurability of effects and achievements.

3.3.2. The types of integrative strategic planning for climate change

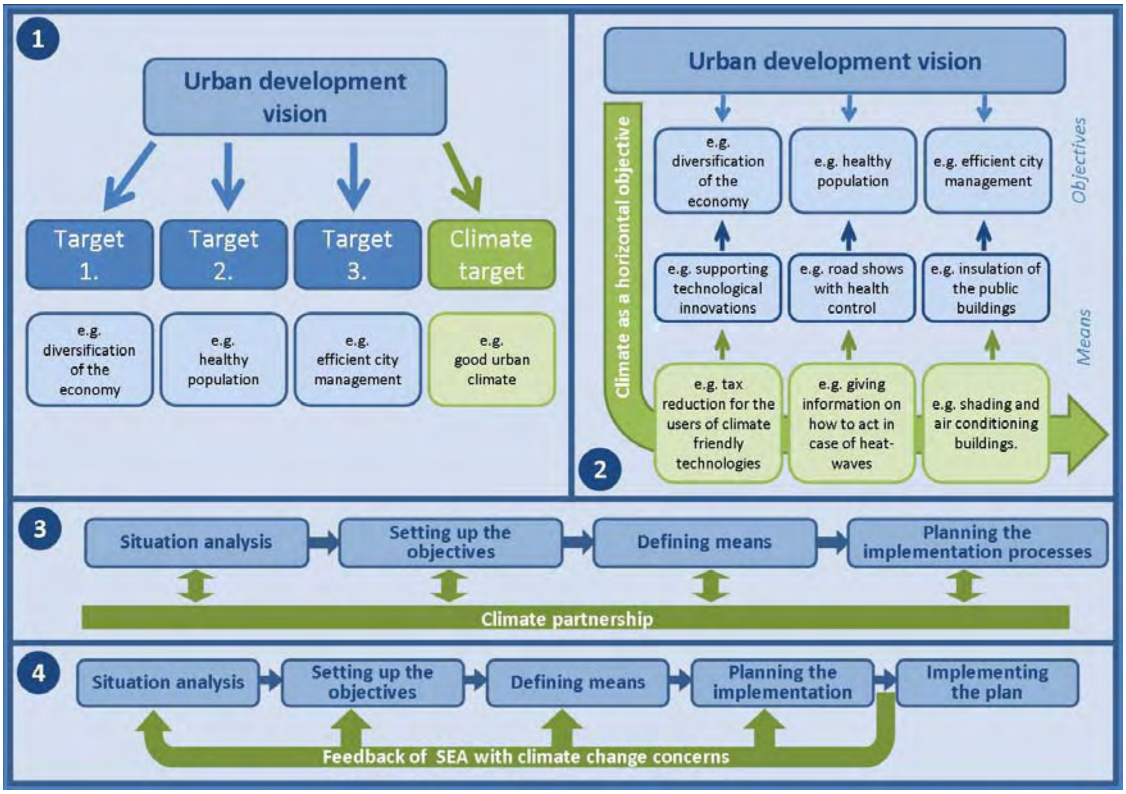


Figure 3: The basic types of the integrative planning

Strategic planning based on stakeholder involvement, communication and iteration, and system approach offers several integration possibilities. During the strategic planning process, as a first step, the planner has to create the form of the integration that is customised for the given planning purposes. Generally, combinations of the following four basic integration types make up the form of planning integration. (These fundamental types are also the building blocks of the possible integration forms of climate planning – discussed in the next part of the chapter.)

- **Integration realized through partnership**: Partnership shall follow each step of the planning process, starting from situation analysis, through setting the targets, up to the appointment of the parties responsible for implementation.
- **With horizontal objectives and measures:** In this case, climate specific considerations are to supplement the city's other, not climate-related, development targets and actions. In order to achieve this, climate change shall be present as a horizontal principle (i.e. all lines of development have to show some kind of positive effect on climate change) or as a horizontal objective (e.g. every relevant development activity should help the city reach given target numbers in terms of outdoor shading) in the urban development planning document.
- **With direct, climate-targeted objectives and measures:** Climate objectives and measures can be defined which directly and exclusively serve mitigation or adaptation purposes.
- **Complementary planning procedures ensuring integration:** Additional procedures which follow the planning process in order to secure integration along environmental and sustainability aims may also be implemented in climate planning. The so-called strategic environmental assessment (SEA) is such a procedure. SEA became a mandatory process in the EU by the approval of the Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment. By SEA, prior to the implementation phase, planning can be informed and amended with suggestions related to climate change concerns.

3.3.3. Direct and embedded urban strategic climate planning procedures and plans

The climate planning process and its documentation are worth to be treated in an integrated way, and to connect these to other planning processes. (Climate planning will not lose from its value and effect merely for the reason that its outcome does not take shape in a separate, individual strategy but is part of another planning documentation.) The following models offer opportunities for favourable planning integration through the preparation of a climate strategy:

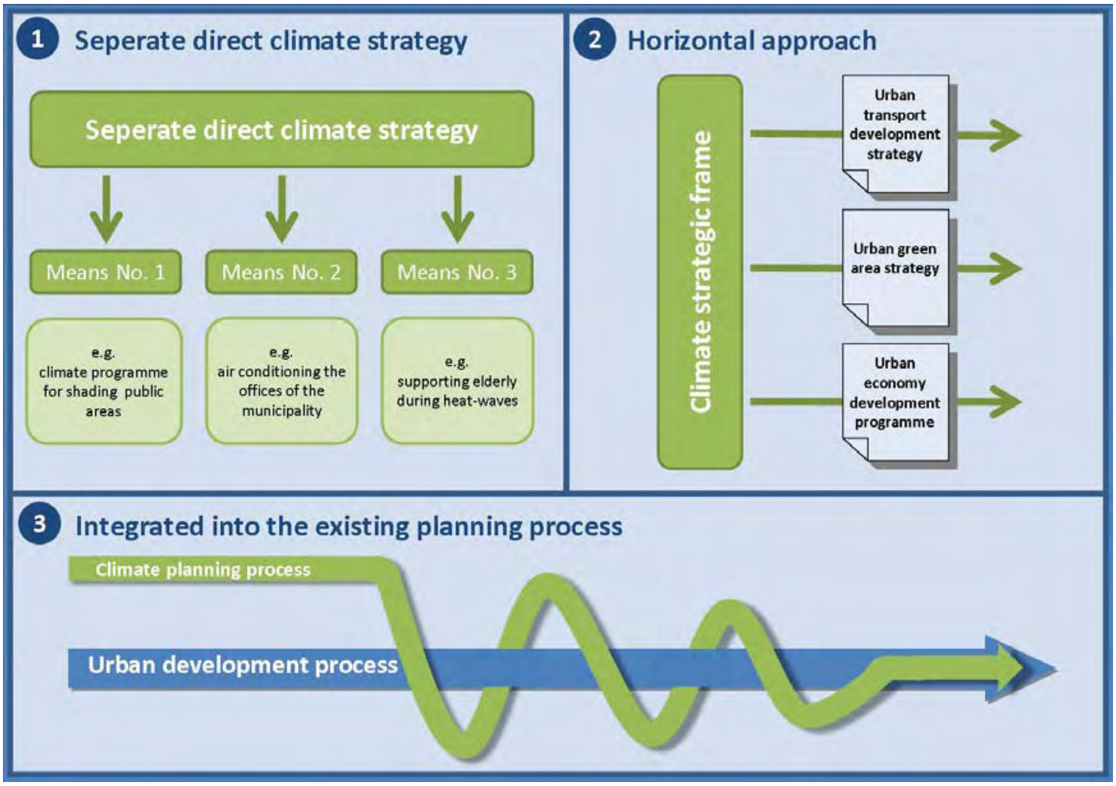


Figure 4: Integration possibilities of urban climate planning

(1) Separate direct climate planning and (2) urban climate strategic frames: our climate strategy is prepared by means of a separate planning process and/or planning document, first of all, it has to be decided whether our strategy will be only a framework document (i.e. implemented by urban programmes which do not have climate change as their main focus), or if it will declare own interventions.

– In case our climate strategy serves only as a framework:
  It has to contain targeted climate-related messages to all relevant and valid plans and programmes of the city that are about to be realised or are already under implementation. Furthermore, in case the climate strategic framework intends to launch interventions that are not shown in any other plan, the **position of the framework strategy** has to be unambiguously defined **in the hierarchy of plans**. Decision makers of the city accept the climate strategic framework being aware of the fact that it causes automatic changes in other plans.
– **A monitoring and evaluation system** providing proper supervision and feedback is the key to the effective implementation of strategic frameworks. This is the only way to find out if a programme falls behind its expected climate performance.
– It is important that if a climate strategy has a framework nature (i.e. other plans or programmes contain its elements) but also includes direct measures in its own competence, these two types of messages have to be clearly separated in its planning document. These two categories are often confused in planning documents, which makes it difficult to unambiguously identify **liabilities**, and thus endangers implementation.

(3) Climate strategies embedded in urban planning: Climate planning may be embedded in an already existing, legitimate planning process (e.g. in an urban development strategy). Importantly, behind this inclusive planning process, there has to be true dedication by the decision makers in urban policy, and thus implementation of the plan is guaranteed. The most important forms of embedded climate planning are as follows:

- **Integration by parallel planning**: A way for integration is when the team of climate planners and their partners follows an otherwise primarily non-climate-oriented planning process (e.g. general urban development planning) from beginning to end. On the one hand, this provides step-by-step feedback to the planners concerning their non-climate-related ideas from a climate change point of view, and supplements each planning phase with climate change considerations.
- **Integration by strategic environment assessment (SEA)**: SEA (Directive 2001/42/EC), which follows the course of urban development planning, can also facilitate the inclusion of climate considerations. SEA has two fundamental types. The externally integrated SEA examines an already drafted planning document, and in case it is necessary, suggests modifications to it. By contrast, the internally integrated SEA starts earlier, even prior to drafting the messages of the plan, which makes it similar to parallel planning introduced above. In this latter case, we may have greater influence on planning.
- **Horizontal integration**: Climate change may be introduced as a horizontal principle or objective into an inclusive non-climate-oriented planning process. In this case, climate change has to be taken into consideration during every intervention of the plan. Horizontal integration can be effective only if the significance of including climate considerations into particular policy areas is clearly explained in relation to each and every relevant tool For example, the action to modernise urban public transportation may also be achieved with low emission and/or air-conditioned vehicles, which may be the means of prevention and adaptation.

  An important condition of success horizontal integration is the measurability of performance by a suitable **monitoring system**. Therefore, climate change related indicators have to be defined in connection to each intervention (e.g. when modernising public transport, data has to be collected not only, for instance, on the frequency of service but also, about emission levels). Compliance with the target values of these horizontal climate indicators has to be considered as a responsibility of the city management.

  Exclusively horizontal integration is adequate and sufficient only in those cases where no large-scale climate development actions are necessary in order to protect the climate of the city or to perform proper adaptation interventions. Those would be difficult to be 'smuggled' (integrated) into other developments.

Rotterdam Climate Proof Adaptation Strategy

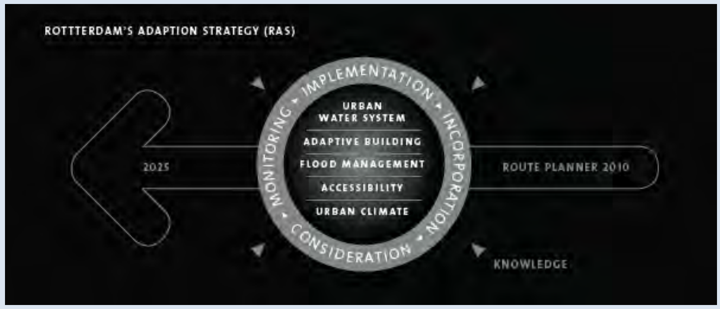
Rotterdam is the second larges city in Holland with population around 600 000. The city located in a low-lying delta will be confronted with rising sea level and exceptionally high or low river levels and floods. Furthermore, the temperature in the city will rise, and heat stress will affect increasing numbers of people. In order to manage the challenge of climate change as an opportunity rather than a threat, the City of Rotterdam has set up the Rotterdam Climate Proof programme. Rotterdam Climate Proof will make the city climate change resilient by 2025. The permanent protection and the accessibility of the Rotterdam region are key elements. The central focus of the programme is to create extra opportunities to make Rotterdam a more attractive city to live, work, relax, and to invest. This substantial ambition will be realized on the basis of three guiding principles:

- Rotterdam will develop into and present itself on a national and international level as a leading centre for water knowledge and climate change expertise.
- Investments in climate solutions will enhance the attractiveness of the city and the port for residents, companies, and knowledge institutes.
- Innovations and knowledge are developed, implemented, and marketed as an export product.

Climate adaptation and spatial development are inextricably intertwined in Rotterdam. The approach applied by the strategy allows urban planners to create designs that effectively address the issue of climate change.

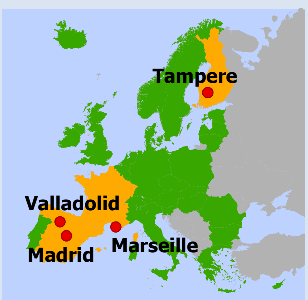
Climate change resilience in Rotterdam will first and foremost involve protection against flooding in the areas inside and outside the dikes in a sustainable way. In addition to flood management, the city will have to focus on other ways to prepare for the consequences of climate change as well, such as higher incidence rates of heat waves, increased heavy precipitation, groundwater salinization, changing ways of water transport, and increased volatility of groundwater levels. What is essential for this adaptive strategy is that it is implemented proactively and that it can be adjusted to changing circumstances. The Rotterdam Climate Adaptation Strategy (RAS) clearly defines the measures that shall be taken to make the area climate proof. The programme consists of five substantive themes which focus on knowledge development and application:

- flood management,
- accessibility,
- adaptive building,
- the urban water system,
- the urban climate.



A number of strategic projects were defined within the programme as well. The focus of these projects is on introducing Rotterdam as a model city and a living example, and on the relating marketing activities. Besides that, the projects will also contribute to knowledge development. These projects include the development of the National Water Centre, Connecting Delta Cities, the floating pavilion in Rotterdam, Smart Delta City, and the implementation of the Water and Climate Marketing Plan.

Contact:
E-mail: info@rotterdamclimateinitiative.nl
Web: www.rotterdamclimateinitiative.nl



Examples of climate initiatives embedded in different urban planning processes

In **Madrid**, the capital of Spain (approximately 3.2 million inhabitants) the strategic document entitled the 'City of Madrid Plan for the Sustainable Use of Energy and Climate Change Prevention' contains the targets of the city in connection with climate change and the energy sector and the measures to be implemented until 2012. The plan treats the management of climate change as tightly connected to the energy sector. Regarding renewable energy, the plan gives the most attention to the use of solar energy as well as to waste management. The plan refers to other plans of the city as well, e.g. it aims at the afforestation of a total area of 8,000 hectares in the Madrid Region, at creating bicycle lanes as part of developing transport, as well as arranging free courses to vehicle owners about economical driving.
In the case of another Spanish city, **Valladolid** (approx. 320,000 residents), the climate issues are also part of an integrated planning process: they are embedded in the framework of the so-called Third Action Plan based on the Agenda 21 programme. The Action Plan has ten project packages, and one of these is expressly about the urban aspects of climate change dealing with, among others, energy and traffic related interventions.
The ECO2 Eco-Efficiency Programme of **Tampere**, a Finnish city, also combines climate protection and energy issues, supporting especially climate friendly urban energy solutions. By 2020 the city would like to reach a reduction by 20% in CO_2 emissions, and furthermore, by 2040, it would like to cover 80% of its energy needs by renewable energy. The plan is closely connected to other urban transport and environmental actions.
Following the individual climate strategy of 2007 in **Marseille**, a document (Charte Qualité Marseille) was published dealing with the environmental issues of architecture and city planning. Its second chapter integrates climate change related ideas. According to its suggestions, for example, green and shaded pedestrian areas have to be preserved despite the increasing building density and number of residents, and covered bicycle storage places shall be installed.

Marseille: www.marseille.fr/sitevdm/document?id=3742&id_attribute=48
Madrid: www.c40cities.org/docs/ccap-madrid-110909.pdf
Valladolid: www.aytovalladolid.net
Tampere: www.eco2.fi

Integrated Urban Development Strategy: Creation of a cooperating and competitive network of vital and liveable cities in Hungary

It was an important step in Hungary in the field of urban development that urban rehabilitation planned and implemented along integrative urban strategies gained greater significance. During the EU-financed development programming period of 2007-2013, according to the urban rehabilitation tenders of the larger cities, a so-called Integrated City Development Strategy (ICS) is obligatory to be drafted based on a predetermined thematic structure This takes the targets and experiences of the earlier URBAN community initiative into consideration; Hungarian cities can apply for funding on the one hand, to broaden the functions of their centres, and on the other hand, with the aim to undertake the social rehabilitation of their underdeveloped quarters.

The ICS is a long-term strategic document of the cities, which delineates the mid- and long-term objectives based on an initial detailed analysis of the various parts of the city. In order to implement the strategy, the cities indicate action areas, and define the projects targeting the goals. An obligatory part of the ICSs' is the so-called anti-segregation plan, within which the cities make assessments of their significantly deprived areas, and they determine a rehabilitation plan for these. Through the creation of these strategies, the enforcement of local partnership and participation is required. Between 2007 and 2013, a sum of approximately 360 billion Hungarian Forints (1.28 billion EUR) has been allocated on such rehabilitation targets.

Integrated urban development based on the principles of the Leipzig Chart, and the actualisation of the climate change objectives pose a new challenge to the cities. Based on the experience from ICSs, the central government inserted this type of plan also into the law on construction, so it has become mandatory for Hungarian cities to prepare ICS type of plans. The newest methodological instructions regarding these integrated urban development strategies draw attention to the analys the climatic situation, and to the consideration of climate change. These aspects have to be strengthened further so that the ICS will be able to deeply integrate and reflect on the climate concerns in all phases of its planning course.

3.4. THE MAIN STEPS OF URBAN CLIMATE PLANNING

3.4.1. A basic precondition in planning: climate-friendly political climate in cities

A basic requirement for effective urban climate planning is an inclusive political environment. In the most favourable situation, this is declared by launching a local climate policy or by assessing the climate effects of certain local political decisions. In case there are no such special political measures present, at least the political leaders have to be committed towards the issue of climate change. It is also important, that this commitment remains across the different political cycles, since both the problem of climate change itself and the tasks involved in its mitigation and adaptation look far into the future.

The cities are encouraged to create climate strategies by different incentives (Cities, Climate Change and Multilevel Governance, OECD, 2009). The most important ones are the legal requirements. Initiatives on the part of local communities and economic actors may also stimulate the preparation of an urban climate policy. Basically, the following factors can influence the motivation and the interest of the city management in a positive way:

- Increased sensitivity towards the long-term environmental, health, and social effects;
- Economic interest formed primarily by climate change mitigation related energy efficiency issues;
- The job creating effects of the new technologies assisting both adaptation and mitigation (green and eco-technologies);
- However, when planning for climate at this local level, we also have to pay attention to the limiting factors. The legislative and decision making competences and authority of cities restrict the extent to which the climate strategy of a city can influence local climate change issues.

3.4.2. 'Planning climate planning'

Considering the fact, that currently there are no obligatory provisions for the preparation of complex, integrated strategic urban climate plans, there is significant freedom in designing the planning process.

In the beginning of the planning process, the responsible parties of planning (in general, the management of the city) and the planning experts have to design the urban climate planning procedure and the characteristics of the planning document to be created: (1) the topic and function, (2) the level, and (3) its actors, as well as, (4) the parameters of the process itself (the schedule, resource needs, etc.).

Favourably, a committee of experts gives further and effective support to the municipality divisions in charge. The committee may be divided into subcommittees based on sectors or other topics. The committee can also provide a framework for building the climate partnership by involving also civil activists and economic actors in their work.

Before starting planning, we have to choose the proper integration form as well (see details in the former subchapters). No matter what kind of solution we choose, it is advisable to consider the partnership in each case as a means of integration. Proper climate planning is participatory planning which results in a plan that may be implemented in a corporate responsibility system. So we have to involve as wide and as colourful part of the community as possible. (We will deal with the partnership later in a more detailed way.)

3.4.3. How to start? – Situation analysis in climate planning

The analysis must assess the future dynamics of the city's climate. The results of climate models have to be considered. Although numerous climate models can be applied, the modelling of a city's climate change can easily exceed the resource and time frames of a planning project conducted by a city. However, it is always possible to utilise the published results of the already developed and applied climate models regarding the encompassing region or macro-region. The climate change vulnerability of the city has also to be investigated. A city's vulnerability shall be assessed according to sectors (health care, heating, water management etc.) and districts. (See Chapter 1 for further ideas on climate modelling and vulnerability assessment.)

In the course of analysis, those sectors and policy areas also have to be studied which are either having an influence on or are being influenced by, climate change. This analysis has to incorporate aspects of both adaptation and mitigation. The climate-relevant urban-ecological elements (e.g. green and water surface systems, solar radiation) and parameters of the built-up environment (e.g. patterns and number of buildings and the housing conditions) have to be investigated. Social and economical trends concerning water and energy management (e.g. consumption patterns), traffic (passenger and goods), and industrial and agricultural production have also to be analysed.

Furthermore, we have to go through the other city development plans and programmes that are in effect and under implementation. We have to try to expose the possible climate consequences of the existing urban development initiatives.

During urban planning, it is not allowed to treat the cities as homogeneous units, since the city districts with diverse characteristics need different interventions regarding the improvement of the urban micro-climate (e.g. densely built-in downtown areas, agglomeration areas with extensive green areas). Therefore, the investigations have to outline the spatial structure of the city in terms of climate change sensitivity, and the varying climate change scenarios of the city districts. We have to assess the individual themes not only separately, but in a complex analysis as well.

The analysis may not be conducted exclusively of the territory within the borders of the city: the climatic characteristics of the surrounding area have to be also taken into account, as well as their effects on the climate of the city (adjacent natural environment may significantly modify the anthropogenic effects on urban climate).

In the course of the analysis, we have to investigate the current and possible local effects of the global climate change (extreme weather, heat waves, radiation, etc.) on the urban environment and on human health, as well as its social and economical consequences.

3.4.4. What is our destination and how do we get there? – Setting up aims and objectives, defining measures

Determining the objectives and the means to achieve them is a very important phase of urban climate planning. The objectives and means of the urban climate strategy – in a proper interpretation – are the measurable and controllable undertakings. Favourably, situation these are not only the undertakings of the leadership or the management of the city but of a large number of city inhabitants, business and civil actors as well.

We may set objectives in connection with urban climate directly and separately (mitigation and adaptation), or we may integrate the climate aspects into other general objectives. These both can be important in planning the climate strategy of the cities.

We may also define climate objectives referring to certain city parts (e.g. increasing the surface of the downtown green areas, enhancing the climate comfort of the residential areas of the Eastern European style block houses built of industrially prefabricated elements, or afforestation in the suburbs). Due to the diversified spatial structure of the cities, an urban climate strategy has to have spatial objectives among its aims which target particular areas or districts; lacking these, it may remain shallow without exact messages.

However, climatic objectives may also be incorporated in the planning documents as horizontal objectives. This solution is necessary especially when the climate strategy is prepared not through a separate planning process and not in the frame of an individual planning document but as part of another urban development planning processes.

In the urban climate strategy, we also determine the means serving the climate objectives. We have a chance to choose from among a large number of different means in the case of each city. Investments performed by the city (e.g. afforestation, locating shading street furniture, installation of air conditioning devices), organisation and mobilization (e.g. organizing afforestation realised by the residents) or consultation (e.g. a campaign for residents on how to regulate the temperature of their flats) may be among the means. A further important means may be the financial support of citizens or enterprises (funding for afforestation or shading), but legislative measures as well (e.g. climate friendly construction regulation). Naturally, the city leadership and management are not solely responsible for the application of these means. Moreover, an urban climate strategy will be successful if it is realized in the co-operation of different groups of the community.

One of the most important factors in the choice of the urban climate political priorities is the time frame for the objectives and interventions. We may separate short-term and long-term interventions both regarding mitigation of the harmful effects of, and the adaptation to, climate change. For example, the construction of a shading system, or the reduction of the greenhouse effect of transport may be implemented on a short-term basis (even in a three-year action plan) in a specific action area of a certain part of the city. These all, of course, do not mean that a short-term climate plan should not have to indicate the (small) steps towards a long-term objective, but these are worth to be treated separately during planning and evaluation.

3.4.5. Measuring success – monitoring, evaluation and indicators in climate planning

We continuously have to follow the situation of the urban climate. We have to collect the relevant climate data and create databases with a proper time scale and territorial breakdown, based on which we may apply climate models providing forecasts, and other scientific examinations may also be supported.

Besides the collection of the data regarding the climate, we have to monitor the results of our climate change interventions. Therefore we have to define an indicator for each case in the climate strategy which shows the output of the interventions (i.e. output indicators, e.g. the number of insulated flats, the size of the green area), the results (result indicators, e.g. the size of the public area affected by direct sunshine, number of residents living and working in the area whose climate comfort has been enhanced), and effects (effect indicators, e.g. reduction of the energy required for cooling). Compared to other urban planning documents, the implementation of our climate strategy has to be also regularly evaluated, at least once during implementation (on-going), and following the end of implementation (ex-post evaluation). Based on these evaluations, by examining the data collected via the monitoring system, we may have to intervene in the implementation, or modify the strategy.

During the evaluation of the climate strategy, it is worth assessing the progress of the other plans and programmes of the city. We have to consider what kind of results and effects the other urban developments have. Above all, attention has to be brought to developments having unfavourable climate effects, and we have to initiate their amendment as well in time.

3.4.6. Who is responsible for what? – Creation of the implementation system in climate planning

The political and professional representatives of the climate strategy have to be nominated as well. Besides this, it is also important that the cities possess a group of experts which is able to collect the data and information about changes in the urban climate, and who can plan the adaptation interventions. These experts will be able to evaluate the climate strategy of the city. As already mentioned above, we have to try to involve further urban actors into implementation with defined responsibilities.

In a favourable situation, the implementation of the plans in connection with climate change is not only the responsibility of a designated organisational unit, but instead, it takes place in co-operation; and it is a common responsibility of different urban institutions.

BRIEF RECOMMENDATIONS

- Urban climate planning cannot be a separate process, but has to connect to the development and management procedures of the city in an integrated way.
- During their climate planning, the cities have to deal with their mitigation and adaptation possibilities. Especially the latter one is a slightly less significant element of contemporary urban climate plans, andit has to be enhanced further.
- The planning principles and means becoming part of the current strategic planning practice may and shall be applied in urban climate planning for the enforcement of the horizontal policy of sustainability. Therefore, in the different planning activities of the cities:
    - The implementation of strategic planning has to involve the partners affected by climate change.
    - Strategic environmental assessments going parallel with planning have to incorporate climate change as an aspect.
- When we perform an urban strategic planning process involving climate aspects, we have to indicate the climate-political ideas in all of its phases (situation analysis, setting up the objectives and determining actions, planning of monitoring and evaluation, and implementation).

4. CLIMATE FRIENDLY URBAN STRUCTURE AND LAND USE

As covered in an earlier chapter, climate change is concentrated in the cities, not only in terms of its causes, but also in respect of its impacts and the problems which arise from it. The built-up parts of urbanised areas warm up more (due to their higher albedo value), particularly as the emission of greenhouse gases is higher due to the heavy traffic, to which the direct effect of the infrastructure, heating, transport and production – so-called thermal pollution - also contribute. The enclosed character of the settlements restricts air movement and the possibility of ventilation is also limited, further compounding the problem. Besides the temperature change, several other ecological conditions are also modified in built-up areas, for example the reduction of the air's moisture content and disruption of the water cycle. The more built-up a settlement is, the more this affects the micro-climate. This means that due to the higher number of residents in a city, the unfavourable impacts and dangers affect many more people's quality of life, and hence require increased attention. Over and above their contribution to global climate change, it is also important that at local level we understand and manage the factors resulting in the change of the micro- and mesoclimate; besides adaptation, reducing the modification of the local climate is also a relevant task for cities.

The spatial structure of cities - the location of the different functions, the spatial structure of the connections, the physical, spatial morphology and land-use patterns - is of significance in reducing the concentrated emissions that result in climate change, as well as adaptation to climate change. Naturally, the geographically determined and historically developed structure of the cities may not be restructured in the short-term; however, alongside concerns such as sustainability, efficiency and quality of life, climate protection may also play a significant role in local strategic policy on urban spatial structure, prioritising land-use development with clearly stated, wider goals.

4.1. STRUCTURE AND CLIMATE

A city's spatial structure determines several aspects of the urban climate. From a climatic point of view a key factor of the urban energy balance is the perceptible and latent heat effected by the city's layout, which depends on the situating of vegetation, on the proportion of paved surfaces, on the characteristics of the urban morphology and of the physical layout of the city, as well as on its horizontal and vertical division, the development of shading and on the natural ventilation capability of the streets. With the localisation of urban functions and the proper design of spatial networks, accessibility between two places can be improved and the city's traffic needs can be significantly reduced; the latter is responsible for most harmful GHG emissions. The spatial development of residential areas, from both a quantitative and a qualitative perspective, and the shaping of residents' and organisations' typical traffic routes, are important issues of designing settlement's structure. Temperature increase of the surface can be influenced by the careful choice of land-use and its spatial organisation, while the spatial structure and density of buildings determine the settlement's ventilation potential.

General climate-modifying land-use arrangement principles are the following (based on Nagy I. 2008):
- temperature reduction by limiting paved surfaces (increase of water surfaces and surfaces covered by vegetation);
- limitation of irradiation by shading critical areas;
- increase of near-surface airflow in order to ventilate polluted air;
- establishment of air filter zones in order to reduce heavy pollution;
- attaining favourable micro- and mesoclimate, and thermoregulatory effects;
- colour of façade, its covering with green vegetation.

Through avoiding certain types of production or influencing their territorial separation, the concentration of pollution may be significantly reduced.

It follows that urban land use oriented structure (spatial) planning has a determining responsibility in the field of managing climate change at local level. Land-use zoning policies have a wide-ranging, long-term effect on sectoral policies to address climate change. Spatial planning affects the placement of the built environment and therefore the distances required for urban travel, the energy required to heat and cool buildings, and the vulnerability of the built environment. Urban master plans and land-use zoning policies determine the set of land-uses that are allowed in a particular zone – at the most basic level these include residential, commercial, industrial open space and mixed uses – and the degree to which land-uses are separated from one another. These decisions shape the built environment and determine long-term travel patterns, building placement, access to amenities and exposure to natural hazards. Land-use zoning policies impact transportation and GHG mitigation policies by determining the degree of segregation among land-uses and therefore energy required to travel between home, work, shopping and other activities. (OECD, 2010) The importance of urban structure planning, land-use planning is also increased by the fact that the other possible areas of intervention to be introduced in other chapters of this handbook – e.g. transport, infrastructure, architecture, etc. – are also influenced by the city structure, the spatial plans and land-use regulations determine their constraints and possibilities in certain locations.

It is important to emphasise that the urban structure planning should be based on the on the integrated strategic planning, which was already introduced in the third chapter. A good strategy based settlement-level masterplan defines territorial structure, which serves strategic objectives and, besides the direct ecological aspects, also takes into consideration the social needs and economic realities which differ from area to area.

Appropriate planning is not worth anything if its content cannot be realised and enforced. As well as regulation related to settlement-structuring, a wider and multi-level set of tools is needed for realising planning goals, to help influence the economic players and the residents – in partnership – in order to create the desired spatial structure. Some considerations on the tools of implementing the spatial plans are introduced in chapter 4.8.

We have to make clear that the creation of a sustainable urban structure which is also ideal from a climatic perspective is not one shot process, but a **constant effort to shape and controll the urban system**. Generally, these structures cannot be constructed but rather the existing settlement structure can be adapted and formed one step at a time, in order to get closer to the desired status. The level of success of the interventions depends on the degree of organisation, the local authorities' financial power, and the success of the partnerships created for the programme's realisation. Climatic considerations can be maximally enforced when constructing a new district and they may also be relatively widely applied during comprehensive urban rehabilitation. Normally there is opportunity only for smaller interventions, for example, through one or other development investment or while revising certain planning tools. However, in order for these small steps to lead to an even better structure, it is important that solid objectives and principles be identified that can be enforced during the actual decision making processes, and that these be instrumental in every decision. However, it is also essential that urban development be accompanied by a continuous monitoring process that takes into consideration climatic aspects and is integrated into decision-making processes. Beyond the regular urban environmental data collection, the transparency of these information and communication are essential aspects of climate friendly planning.

The climate-friendly urban structure has no unified European 'recipe'. The difference in climatic zones, geographic circumstances, the historical structure heritage of settlements, and even the different lifestyles of the various regions requires specific solutions. Within the scope of this chapter a few, in most cases legitimate, urban structure-forming considerations are introduced which may be successfully implemented in urban planning and development, and while developing solutions adapted to particular urban circumstances.

What is a good structure like?

If we want to find an answer to the question of what kind of factors determine whether an urban structure is climate-friendly or not, then we have to take into consideration the city's **developmental period**. Generally, literature defines four phases in long term urban development. The first phase is an explosion in the city's growth (quick *urbanisation phase*). It is followed by period, when the suburbs are growing, often the too-quickly expanding city 'swallowing up' the surrounding settlements, and in many cases it leads to the so-called *urban sprawl (suburbanisation phase).* The next phase in the development of the settlement structure is the so-called *dezurbanisation*, when urban-type development and services reach the distant, rural areas as well. Finally the *re-urbanisation* phase comes, when the population of the metropolitan core area starts to grow again. In reality these phases are not periods following each other, happening due to necessity, but dynamics working parallel to each other which form the urban structure with varying intensity. These processes may be restricted or stimulated with different measures but first and foremost have to be channelled in such a way that the effects shall be favourable in respect of the city's sustainability, or at least mitigate its negative consequences. When identifying local climate policy's objectives and measures we have to consider whether, at a given time, in a given city, the dominant dynamic is one of suburbanisation and sprawl, re-urbanisation or other.

From a climatic perspective, the suburbanisation phase - the expansion of urban construction - is theoretically the most damaging; however it is important to see that in certain cases and with proper preparation, from certain climatic perspectives it may assist the diffusion of critical urban concentration. Re-urbanisation - renewing the inner urban areas - is primarily positive from a sustainability perspective, although with improper implementation, urban rehabilitation may have disadvantageous climatic consequences, e.g. construction in wind corridors, increasing amount of traffic congestion, etc. However, this climatically desirable later period is not inevitable, and is only realised in small areas. If spontaneous, re-urbanisation will only be partially successful, therefore organised support and coordination is generally necessary. In theory, the process of dezurbanisation assists polycentric development and strengthens rural resilience. However, there is a danger that due, for example, to low real estate prices, this can result in the turning relatively large areas into urbanised areas with e.g. high density of mineralised surfaces.

Geographic location fundamentally determines what structural factors are favourable or unfavourable. As was introduced in Chapter 1 of this handbook, cities are faced with entirely different challenges in the different climatic zones. For example, in the mid and southern parts of the continent, urban heat islands have to be counteracted and climatically favourable residential areas have to be created, whereas in flood risk zones the instruments of flood defence and supplementary reservoir areas have to be provided for in the spatial structure. While in wetter Northern Europe rainwater has to be drained, and – in the name of sustainability – retained and collected, even possibly reused, the coastal and low lying cities have to take into consideration the rise in sea level when creating long term settlement structure. Besides these main types, every settlement has to be evaluated on its own, depending on the given place and within the given circumstances, to identify what qualifies as sustainable.

It is nevertheless possible to state **general aspects** for creating a climatically and sustainably ideal urban structure, which is acceptable to Europe, too. Generally the urban structure is climate-friendly if it can contribute to decrease in emissions and in a spatially selective way reduce unfavourable impacts and aid adaptation. 'The sustainable urban spatial use is characterised by diversity both vertically and horizontally. The sustainable settlement structure constitutes a pattern of urban functions and public transport that result in a low resource use (ecological footprint).' (Dr. Klára Hajnal).

Key issues:

- The proportion of different **land-uses** and their spatial pattern is also of determining significance. From a climatic point of view, the green areas, water surfaces and other non-developed open spaces generally represent a favourable land use, while the constructed, covered surfaces are primarily unfavourable.
- Developments resulting in the excessive use of land need to be avoided, and it is suggested that greater emphasis be put on the creation of **green area** networks, which separate different land-uses in the city, while maintaining their connectivity. This has significant positive effects on the urban climate, for example, the cooling effect of the green areas through evaporation, or by ensuring ventilation which improves urban air quality. We have to choose material with a lighter colour for their favourable albedo and higher reflective ability, and at the same time properly insulate.
- During urban planning the measureable, so called rate of **biological activity** needs to be increased or at least maintained. This is laid down in law in certain countries (e.g. in Hungary).
- Ensuring **spatial order** and increase the **level of planning** is essential from the point of burden on environment, of efficient and saving land-use, and even of the citizens' quality of life. It is necessary to separate the areas serving different functions; however these should not be too far from each other as, for example, the larger the distance between the home and the workplace, the more significant the impact through increased transport needs.
- Special attention needs to be paid to the location specific **sources of risk** or danger emerging along with climate change when shaping the urban structure and during construction work. We have to avoid construction and other intensive uses of areas at risk from extreme weather due to climate change – e.g. subsidence, landslides, vulnerable to flooding. It is a general rule that the deeper lying areas, inland areas prone to flooding and areas with subsidence may not be constructed on. However, these risk areas may become a valuable part of the green area system through e.g. forestation.
- Flooding is the most important effect of climate change in seaside cities and cities lying close to the rivers of Europe. Unique **water management** tasks need **integrated into urban planning** when reorganising the settlement structure, thus providing dams, support reservoirs, filling up the areas available or made available as part of the revitalisation programme, etc.
- Determining the ideal **urban density** of the population, technical infrastructure, workplaces and institutions is of key importance. From a climatic perspective, in general dual, partly controversial targets have to be followed. On the one hand the extensive spread of the quantitative urbanisation, the expansion of construction and spatial reorganisation has to be stopped; on the other hand, the damaging effects resulting from density, for example, heat islands and smog, have to be avoided. It is generally true that, if possible, 'space consuming', sprawling, very low density urbanisation has to be avoided, as well as the over-concentration that encourages unfavourable climatic effects. In order to understand this topic more deeply, in the following we will go through the different aspects of compactness, dividing and polycentricity.

General aspects of the creation of the climate-friendly city structure:

- reduction of travel needs, optimisation of travel connections,
- avoiding production activities causing air pollution, as well as their spatial optimisation,
- taking into consideration the environmental geographic conditions of the area,
- reducing the proportion of those types of land use resulting in higher warming,
- efficient and saving land-use,
- compact structure,
- dividing the urban territory,
- enforcing polycentric urban structure,
- ensuring cross-ventilation,

- reducing, stopping or optimising the encroachment of urban functions and construction (urbanisation of the neighbouring rural settlements, near-wild and agricultural areas),
- the energy and material cycle of the city (urban metabolism) increasingly located in the local - regional space,
- high biological activity rate and green network,
- dealing with extreme weather situations in the city structure (flood canalisation, support reservoirs, dams, etc.),
- favouring public transport and spatial optimisation of its networks.

4.2. COMPACT AND SEPARATED

Today, from a sustainability and efficiency perspective, the compact city model may be considered the most supported urban development paradigm. **Based on the model of the compact city structure** the aim is to optimally locate activities and development to avoid urban sprawl, to contain the development processes and urban expansion within a clearly defined area and clearly marked boundaries.

Between boundaries

City life is characterised by constantly changing functions. The population, economy, the needs of its inhabitants or the needs of the institutions change continuously. Thanks to this certain functions are overshadowed and devalued, while new needs search for mostly new – and not least, cheaper – locations to develop. A typical example of this is the construction of plazas which in many countries – including a near explosion in growth in the majority of the new market economies in Eastern-European countries – are located in the suburbs, often as green-field investments, because in the inner urban areas these would be more expensive and less accessible by private car, or because there is no real estate of a suitable size. A similar example is the restructuring of residential space, when the living quarters of the earlier, inner city areas are no longer sufficient due to an increase in the standard of living, changing demographics, or due to physical features such as the size of the flat, the degree of comfort, available sunshine, and internal height. As a consequence, due to the lack of properly planned interventions, the former residential areas become abandoned and later undervalued. Inner-city poverty will become concentrated here, while on the outskirts of the city or in the neighbouring settlements a new housing supply appears to meet modern needs.

What are the main arguments for the compact city?

On the one hand, in the case of higher urban density, public transport and public utility systems are generally more efficient and their energy demand is lower. A city remaining within its own boundaries does not erode the contiguous, biologically active areas. The variety of services and workplaces make the city a better place to live and reduces transport needs. However, this latter argument is not always true as many services used by residents are further away, or they find a better workplace in a different location, and therefore there is a huge movement of commuters between certain parts of the city (agglomeration) at least twice a day. Those opposing the compact city refer to alienation, the crime problem and the high concentration of factors damaging both the environment and quality of life, issues that are also problematic from a climate change point of view. (K. Szántó – J. Sarlós)
The higher energy consumption of urban transport clearly indicates the in negative environmental consequences of low urban density. (See next figure)

Policy objectives promoting compact urban development aim to control spontaneous urban growth and facilitate a change of functions in inner areas. This process calls for strong coordinating role of the public sphere with high level of planning and strong toolkit of interventions such as regulation and market intervention. For all these we need proper support from society hence it is vitally important that the citizens are also aware of the significance of these questions and their damaging effects. Local society will be more supportive if unequivocal and clear advantages are connected to any imposed restrictions. An example of this may be connecting public parks and open-air recreation spaces to compact, built-up areas, making sure that the urban area exempted from construction is accessible to everybody and is valued as a pleasant, near-natural area with a well-kept landscape. Likewise, within the confines of the compact city it is important to make the most of the residential areas' environmental possibilities, such as, for example, improving air and light quality. So, in the compact city model, development takes place separated from non-urban areas by more or less distinct borders but is necessarily accompanied by an increase in construction in city spaces and a growth in the density of functions.

Nowadays, quantitative urban development continues to go hand in hand with an increased demand for space, which typically still prevails even when the population is not increasing. If horizontal expansion is successfully restricted by strict zoning policies focusing on compact development, the cities' vertical expansion becomes necessary, such as an increase in the height of buildings and an increase in subsurface building. Besides forming the cityscape, **vertical expansion** also determines other factors influencing the climate of the city. Narrow streets bordered by high buildings may provide less optimal climatic conditions for the residents due to reduced ventilation and the constant shading effect, than wide streets bordered by apartments of differing heights. Research into psychology and buildings throws light on the damaging effect taller buildings have on humans. However, there is no doubt that should tall buildings be substituted for several smaller buildings, theoretically the possibility arises to exchange part of the built-up area for construction-free areas; thus from a global warming perspective it is possible to achieve a more favourable land-use that is in all respects preferable.

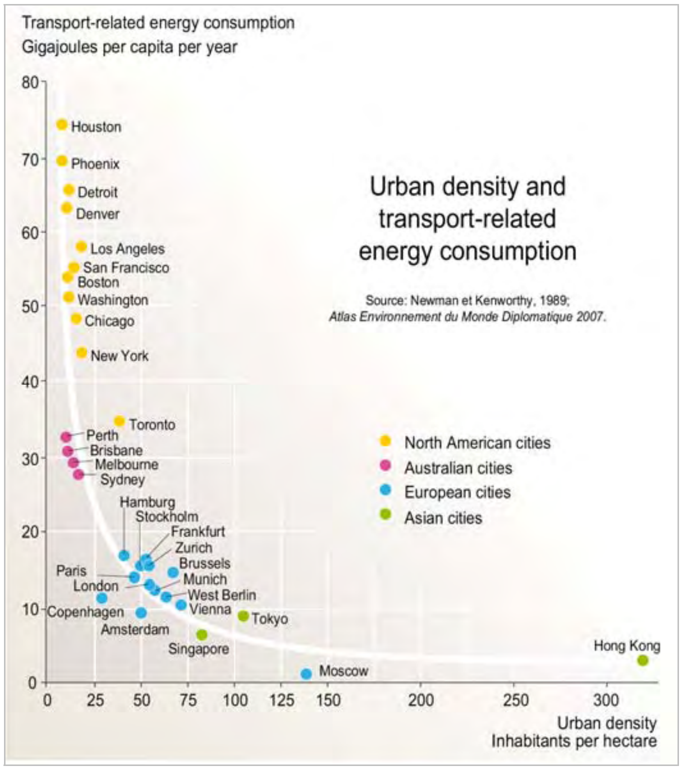


Figure 5: Urban density and transport-related energy consumption

Source and further information: Urban density and transport-related energy consumption. (2009). In UNEP/GRID-Arendal Maps and Graphics Library. Retrieved 11:06, March 31, 2011 from http://maps.grida.no/go/graphic/ urban-density-and-transport-related-energy-consumption1.

Too high human-, development- and real estate density is increasingly problematic from a climatic perspective; hence striving for a compact city is not a solution in itself.

Compact city characteristics:

- high residential and employment densities,
- mixed land-use,
- fine grain of land-uses (proximity of varied uses and relatively small size of land parcels),
- increased social and economic interactions,
- contiguous development (some parcels or structures may be vacant or abandoned, or surface parking),
- contained urban development, demarcated by legible limits,
- efficient urban infrastructure, especially sewerage and water mains,
- multi-modal transportation,
- high degree of accessibility: local/regional,
- high level of street connectivity (internal/external), including sidewalks and bicycle lanes,
- high degree of impervious surface coverage,

- low proportion of open-space,
- unified regulation of land development planning, or closely co-ordinated supervision,
- sufficient government fiscal capacity to finance urban facilities and infrastructure.

Source: Neuman, M. (2005), 'The Compact City Fallacy', Journal of Planning Education and Research, Vol. 25, No. 1, Sage, London, pp. 11-26.

Dividing the city

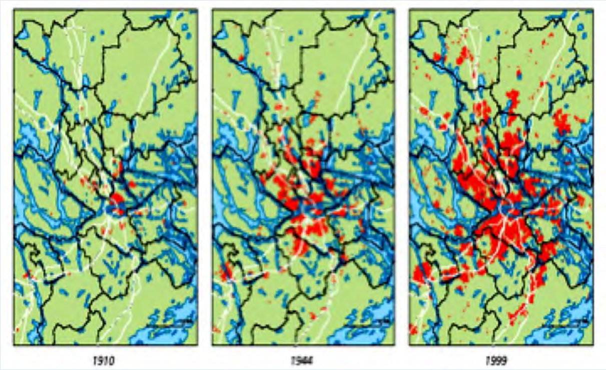
From the point of view of the city's climate, the **division or separation of the urban, highly urbanised and built-up areas** is extremely important. We need wind corridors that improve the city's climate, providing ventilation that, besides tackling warming, also plays a key role in dealing with air pollution and dampness. It is also important for the cities' ecological network to separate according to green areas.

Stockholm, 'the city building inwards'

The challenge of urban sprawl in the Swedish capital, Stockholm, was tackled by a method based on complex incentives. The following pictures show clearly the long-term process of urban sprawl which led to the principle of the 'city building towards the inside' being targeted in its development plan, 1999. (H. Bekele, 2005)

Hammarby Sjöstad, an early industrial quarter, was turned into an area with residential and commercial use as part of a brownfield investment. The development project demonstrates many excellent examples of environmentally-friendly solutions: recycling facilities were built, public transport was developed, and recreation areas were created. In the suburban zone the polycentric structure played a central role.

A polycentric settlement network cannot be achieved unless there is a possibility for the smaller settlements to raise the number of their residents, too. By connecting these settlements to the city centre (with high speed trains), those people migrating out of the city had more possibility to choose their homes, hence population density can even out. The increased efficiency of public transport can lead to a reduction in the need for individual transport, thus environmental pollution and time spent on transport is reduced.



Contact:
Web: www.stockholm.se

From division point of view open lawn areas are also useful, as, should the daily temperature be high, they are able to cool down at night. Similarly, water surfaces are also important in that they have an especially favourable climatic effect. At the same time, **green and other non-built-up areas** of the city may fulfil the people's need for green areas and open spaces (parks, open air sports facilities, etc.) close to their homes. It improves the inner city residents' quality of life and raise the value of urban residential areas, an important factor in slowing down suburbanisation reinforcing reurbanisation, too.

Wind channels, aided by the constructed urban environment, have to be included in longer term planning, taking into consideration the prevailing wind direction (which may vary according to seasons), the geomorphology of the surrounding land (mountains, valleys), as well as the water surfaces and local land-use, after which they should be consistently taken into consideration during urban development and structuring decisions. When determining the divisions in the mass of the city, e.g. avenues, grassy parks, and also parking lots can be considered as open areas for the prevailing wind directions. Construction has to be restricted along these axes; moreover, any existing and unfavourable construction should be removed as part of urban rehabilitation. The system of ventilation can be organized for the naturally open spaces, e.g. the larger rivers. The possibility of ventilation is particularly important in those areas of the city where is risk of high concentration of emission, e.g. streets with high car traffic must be wide enough and the distribution of buildings along the street must ensure the ventilation.

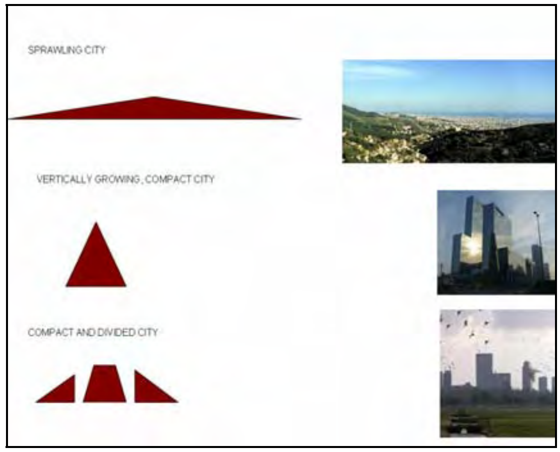


Figure 6: Examples for the structure of the city (G. Salamin)

4.3. POLYCENTRIC PATTERN

Polycentric development and the polycentric city network has become an important element of European thought and is stated as a common objective in the European Spatial Development Perspectives (ESDP) and the European document entitled the Territorial Agenda of the European Union (2007).

The model of polycentrism – as opposed to territorially concentrated development - means the territorial spread of resources and growth dynamics, although within a particular given area it calls for a certain type of concentration and strengthening of centres that results in a more balanced spatial structure. This also deserves attention from an enviro-climatic perspective as it helps to find the balance between economic activities and urbanisation's environmental impact, without either of these becoming excessive and increasing climatic modification. Within a region this aids effective and prudent land-use and does not lead to urban sprawl or extremely heavy transportation needs. The advantage of many smaller sized centres as opposed to a few big centres is that there is a larger space available for renewable resources (geothermal, solar energy, rainwater collection, etc.) within the own region of the city.

At national **and regional level** polycentricity concentrates on the spatial distribution of the centres and emphasis is put on strengthening the weaker centres. This may be considered as beneficial from a climatic point of view as:

- energy consumption and the climatic load is lower due to smaller commuting distances;
- no 'hotspots' are created, and the 'urban load' is more evenly distributed;
- contiguous, built-up, 'grey' zones are smaller within the green space, hence it is easier to deal with pollution hotspots.

Sub-centres in the city region

When considering the climatic consequences of polycentricity at the level of the city region, we find many similarities to the national level. The city centre is becoming more and more congested; it imposes such a heavy burden on its environment, including the climate, that its negative impacts have become largely uncontrollable. However, if this can be divided by green areas within an urban region, and can be separated into multiple centres contamination stays at a manageable level. If workplaces can be created in the city region's smaller settlements and services can also be provided in the localities, this reduces the need to commute and the corresponding energy use.

The polycentric city

The circumstances which negatively affect the urban climate are increasingly prevalent in cities with a single centre. This can be attributed to several factors: for as long as the density is higher in the centre, the pollution caused by commuter traffic is concentrated; the green spaces and non-built-up areas which support ventilation are widespread and lie far from the settlement's core, hence are not able to compensate for the damage caused by air contamination, noise, etc. Should a settlement have multiple centres (and these are functionally balanced), then it is possible to spread these loads among them, thus the unfavourable effects – also from climatic aspect – can be more easily balanced.

In a well-functioning polycentric city the need for travel is reduced, as the sub-centres are able to ensure a higher level of services and number of workplaces. Cities with multiple centres, where those functions serving basic needs (e.g. food shops, etc.) are within walking or cycling distance, have a more evenly distributed and lower environmental impact and provide residents with better living conditions than a one-centred city. The advantage of the polycentric urban structure is that by dividing the urban burdens it is easier to counterbalance different types of pollution, so the extremities of the urban climate may also be treated more effectively. For example, as mentioned, the reduced demand for transport obviously leads to lower traffic-related emissions. Cities like this may also be better from a quality of life perspective, as the environmental and social conflicts rooted in urban density, as well as the extremely high costs these incur, are less prevalent. At the same time, many of the 'liveability' advantages of middle and smaller cities can be found here.

It is possible to support the establishment a polycentric city by using different tools at the same time. **Transport** systems have to be created in a way that improves the accessibility of the sub-centres; special attention needs paid to strengthening public transport, including rail-based solutions. At the same time, the pedestrian and cycle routes to the centre have to be created for the surrounding areas, whether these already exist or are just planned. It is also necessary to create transversal connections between the urban sub-centres, so they can communicate while avoiding the traditional centres.

It is necessary to set up central functions by, on the one hand, establishing or expanding already existing **state-municipal institutions** and, on the other hand, by **encouraging investors**. In the latter case it is important to introduce incentives such as creating an adequate supply of real estate, offering tax reductions on certain places for key functions, or highlighting the future role of the area through communication. Community spaces, public spaces, parks, or urban design elements and the location of more definite architectural 'signposts', all can play an important role in the creation of sub-centres. Naturally, all these shall be included in the land-use plan and the urban building regulations. In respect of demand for land to establish city centres, it is important to support brownfield investments and the functional change of already built-up areas, avoiding the conversion of those areas not yet built-up.

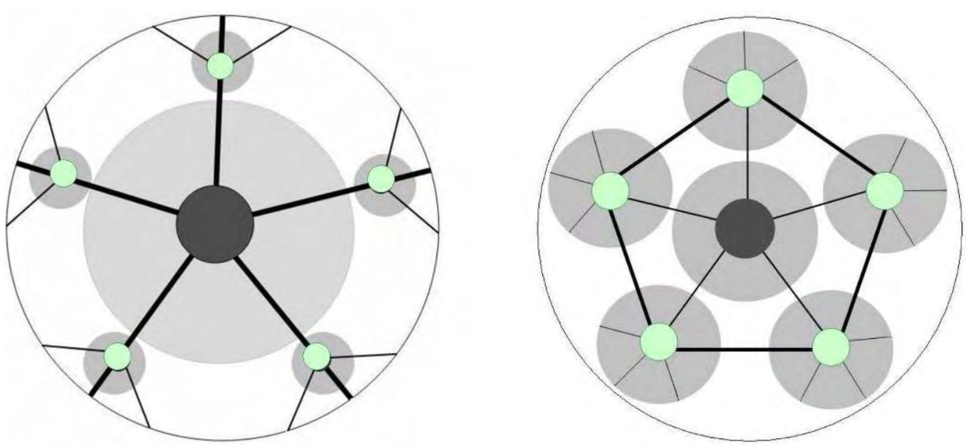


Figure 7: The theoretical sample of the traffic structure of a city having one centre and a polycentric city (G. Salamin)

4.4. URBAN RURAL CO-OPERATION, HANDLING THE TERRITORIAL SPRAWL OF THE CITIES

As was introduced earlier, the tasks of the urban areas in connection with climate change may not end at the city border, since the bigger cities form a closely connected system with their wider region, thanks to their ever more intensive socio-economic and environmental relations.

The division of labour between those cities with a central role and the agglomeration and all the hinterland, which provides agricultural land and production, has been in existence since the beginning. Urban-rural relationship has changed with the different stages of urbanisation, which has resulted in challenges (e.g. urban sprawl) as well as opportunities. The recognition of the factors of sustainable development - the strengthening of urban and rural connections and their partial reinterpretation - offers strong potential for the creation of sustainable urban regions. The ecological functions of the closer and more distant areas and green spaces – important also from a climatic perspective - shall have more value for the cities. Chapter 4.6. presents in detail the role of the green areas around the cities and the possibilities of their development.

4.4.1. Food from the neighbourhood! Strengthening the trade co-operation within the region

Revitalising the role of the area surrounding cities as a supplier of traditional food and raw materials could potentially strengthen sustainability and at the same time strengthen the internal cohesion of urban regions. Should the distance a product travels from producer to consumer be shortened, then the carbon-dioxide emission of the concerned product may be significantly decreased. Furthermore, this relationship also benefits the local economy, helps ensure food safety, as well as the feeling of responsibility which citizens have for area’s values. Urban regions are those territorial units which are sufficiently complex to be self-sufficient in certain respects, have the ability to organise a market, and a critical mass in terms of purchasing power.

The urban sale of the neighbouring area’s agricultural products may be supported by several **means**:
- preference given to traditional markets in cities through both regulation and taxation;
- modifying the main touristic and community squares in the city to allow them to hold occasional markets;
- supporting intensive agricultural production in the peri-urban areas;
- preference given with administrative advantages or tax reductions to the region’s producers;
- local supporting opportunities for direct sales for farmers of the region;
- local and regional food branding, establishment of trademarks;
- awareness-raising among urban residents and popularisation of local products;
- encouraging co-operation between regional sellers and producers, supporting networks, and the creation of a quality assurance scheme.

Naturally, other further forms of co-operation between the city inhabitants and the neighbouring farmers may be developed, ranging from countryside tourism to co-operation in the fields of education and culture. However, it also has to be said that self-sufficiency (which, as mentioned earlier, is significant from an enviro-climatic perspective) in renewable energy systems (ground heat, solar energy, wind energy) and water supply can also be strengthened, should the city meet its needs in unity with its surroundings, and within the frame of the urban region.

TERRES EN VILLES, a network in France supporting cultivation around the city

The Terres en Villes is a network made up of local organisations whose main target is to protect, strengthen and position cultivation close to the city. This initiative includes surrounding forests and the whole unused area around the city. Special attention is paid to the sustainability of the built-up areas and the urban regions.

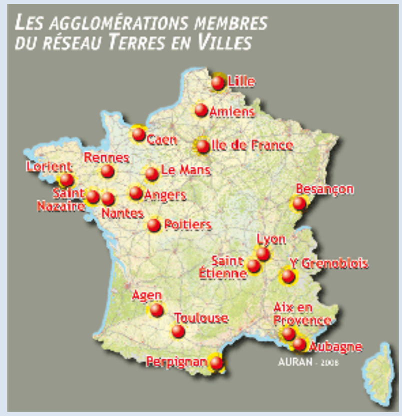
At the moment 20 urban agglomerations are members of Terres en Villes. All cities are represented by intercity agglomeration councils, local agricultural chambers or similar bodies, in close co-operation with the urban development agencies and the French Agricultural Chamber.

The aims of the network of the Terres en Villes are

- to create political proposals in the field of agriculture and forestry in the city surroundings;
- to share experience;
- to exchange know-how amongst the members.

The network and its members work on four main areas

- to draft, cooperatively, the agricultural policies of urban regions, by mapping the present situation, the best practices and the creation of the Terres en Villes Charter;
- to protect the agricultural, forested and natural surrounding areas, and to make rational and reasonable use of the possibilities they offer: to further develop farming technology and the SCOT method (a scheme for agricultural, environmental, urban and county planning) through co-operation between the concerned bodies;
- to collect examples of good practice and regulations on the sale of local products in the city, and the creation of regional product brands and trademarks;
- to form European policies with respect to urban regional farming and the possibilities of uncultivated areas.



Contact:
Secrétariat technique: Serge Bonnefoy
40 Avenue Marcelin Berthelot - BP 2608
38036 Grenoble cedex 2
Telephone : 04 76 20 68 31
E-mail: serge.bonnefoy@terresenvilles.org
Web: www.terresenvilles.org

4.4.2. The city spreads: the urban sprawl phenomenon and its consequences

Since cities began, they have, without exception, been subject to development, expansion and growth, which have gone hand in hand with continuous structural change. Due to the increased significance of industry and as a result of the relegation of certain urban functions further and further away from the centre, the expansion of the city can be seen to have been a centuries-long tendency. In the past half century the relocation of residents to the suburbs has been a determining factor, and this was accompanied by the movement of several other functions – e.g. retail concentrated into the shopping malls, or industrial activity.

During the already-mentioned suburbanisation phase of the urban development path, which follows the explosion in urban growth, the residents and certain economic activities (e.g. commercial functions) move out towards the edge of the city, even to the neighbouring smaller settlements. This sprawl outwards is usually spontaneous, happens through unco-ordinated urban sprawl, and as a consequence is accompanied by a loss of functions in the centre, excessive land-use and devaluation of the inner urban areas, which in turn bring multiple social, financial, economic and environmental tensions. In the countries in the Eastern half of the European Union this process emerged later, but in the last twenty years is characterised by an accelerated 'boom'; the earlier, central planning and the dominance of state property was followed by a new situation, characterised by the market economy, the liberalisation of the real estate market, the increase in private income for certain social groups, motorisation and the settlements' pursuit of their individual, short-term interests.

The local governments of **settlements situated on the outskirts** of cities in a suburbanisation phase, **often significantly extend those territories designated for urban development in the pursuit of short term advantages**; this lacks proper foresight and is contrary to the principles of long-term development and sustainability. This means there is a radical change in the use and structure of the land around the city, where the urban elements tend to become dominant. The urban effects turn the internal structure of the urban region upside down (city and its wider surroundings), even eliminating greenbelts or non-built-up areas, and results in the growth of a significant demand for travel by increasing the intensity of commuting. However, trends going against suburbanisation have also emerged. Urban sprawl has led to an increase in both the amount of time and money needed for travel, and their corresponding costs; these are disadvantages which the better quality of life promised by the suburbs is less able to compensate for. However, this spontaneous reurbanisation does not necessarily result in the restructuring of the urban suburban areas that would lead to the revitalisation of the eco-climatic and agricultural functions.

From the climate change perspective, the most important consequence of urban sprawl is the extremely high energy consumption (commuting, energy supply), the growth in built-up areas, which together extend the extent of unfavourable urban effects. This erodes the green areas around the city which are vitally important from a climatic point of view, while the creation and use of transport, the public utility network, and public services waste land and energy.

However, it has to be mentioned that those rare suburbs which have proper restrictions on the intensity of construction, have adequate central functions can have their own climatic advantages. The larger land areas which belong to the properties make it possible, for example, to utilise local, closed-system, ecological, infrastructure solutions, such as the use of rainwater, solar and geo-thermal energy, wastewater treatment, etc. A garden suburb created according to sustainability principles and less built-up, can have higher biodiversity than cropland, for example.

Key factors in our final judgement may include; restrictions on construction and environmental transformation; reduction of increased commuting needs (with working from home, local centres), the use of locally-contained eco-technologies such as solar energy, instead of large scale infrastructure, etc. As a result of global crisis, society has shown a greater need for the ecological services provided by the countryside (carbon sink, biological diversity, protection of drinking water resources, nature-friendly recreation, etc.) that has resulted in the spread of (land-use) restrictions that serve protection (unfortunately, in many cases, too late).

The consequences of urban sprawl from the point of view of sustainability and climate change:

- increased amount of private traffic,
- increased energy consumption,
- increasing size of areas which are unfavourable from a climatic perspective,
- increased infrastructural needs, increased costs of the infrastructure and services,
- decrease in green and non built-up areas around the cities,
- excessive land-use,
- social isolation, the organisation of public health supply for the elderly becomes much more difficult,
- it is even more difficult for everyone to find ideal transport solutions and make these attractive while ensuring quality,
- increase in time spent on travel, mainly for commuters,
- economic downturn in the traditional city centre,
- negative effects resulting in the decrease in the quality of the countryside and the natural environment,
- exploitation of ecological and cultural values,
- loss of good quality agricultural areas, soil erosion,
- destruction of habitats, fragmentation of the ecological systems and reduction of biodiversity,
- endangering the cultural landscapes and their fragmentation.

4.4.3. What is needed? A common system of values, responsibility and strong policies.

A basic principle of the handling suburbanisation and sprawl is that the whole affected urban region should be adequately co-ordinated and some kind of governance should be implemented, based on planning for the whole region and with the co-operation of the urban and rural participants. In order to achieve this there is a need to define common interests, the objectives of the participants, and the strategic definition of common goals; these need to be decided for the whole city region, according to multi-level governance as described in Chapter 2. It is important to have national level policies which encourage the treatment of urban-rural problems through sectoral policies, by legislation and by the motivation of the local-regional actors.

An urban sprawl policy oriented towards the sustainability of the urban region may be built on the following principles:
– commitment to common responsibility at the urban region level;
– long-term, conscientious, future-oriented thinking;
– partnership at urban regional level, common planning;
– acknowledging the need for a green, liveable, healthy, residential environment.

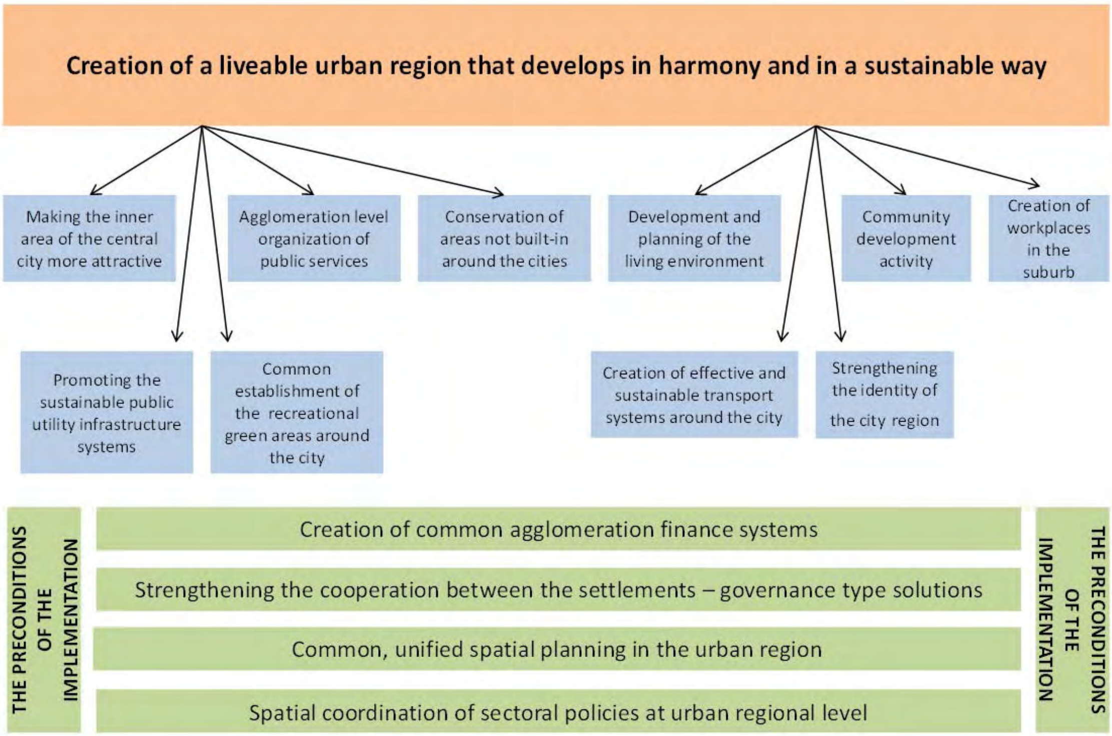


Figure 8: Possible strategies for managing urban sprawl, growth of the agglomeration (VÁTI, 2009)

4.4.4. Spatial planning at city region level: sustainability and climate related considerations with special reference to urban rural co-operation

One of the most important areas of co-operation between the settlements is systematic planning ensuring community coordination. Spatial or urban planning is usually the competence of local authorities or, in some cases, regional institutions. Although in certain cases legitimate governmental and planning institutions were created at the urban agglomeration level (e.g. Budapest agglomeration, Dutch city regions, metropolitan region in Germany from the middle of the nineties, etc.), the concerned administrative bodies and local governments can successfully plan and co-ordinate urban regions, basically by sharing their own planning competences and through voluntary co-operation. The themes that should be **commonly planned** can easily be different in the case of urban regions with different conditions, size or geographic characteristics. However we think that it is usful to **determine certain general considerations** for joint planning in city regions with special reference to urban rural co-operation and aspects of sustainable development and climate change. (See the boxes below)

General sustainability and climatic aspects for joint-planning of urban regions:

– creation of sustainable, not excessive land-use,
– avoiding intergrowth of built up surfaces between the settlements
– ensuring the continuity of the ecological network,
– reduction of transport needs through spatial organisation,
– principle of polycentricism - polycentric urban region and cooperating group of settlements,

- delineation of areas primarily suitable for forestation, determination of the areas not proper for intensive agriculture,
- rehabilitation of inner cities, increasing their attractiveness.

Possible thematic areas and aspects in respect of joint-planning for urban regions and agglomerations

Regional green space and recreational facilities
Aspects:
- The green belt; the green system around the city has to form a useful zone in the space surrounding the city. The task of planning is to indicate the main zones and sectors. All activities that reduce green areas or erode the landscape, natural and aesthetic value need to be avoided; furthermore, the necessary recreational infrastructure has to be developed. Securing the ecological network is important as is the increase of forested areas.
- In forest and lawn management surrounding the city, ecological, protective, climatic and recreational factors need to be given preference over economically productive considerations. (See more information on peri urban green areas in subchapter 4.6.4)

Economic zones and developments with regional significance
Aspects:
- Locating an optimal (space-saving, sustainable, easily-accessible) solution for the whole region – and hopefully for the investor - which provides larger added value at regional level in respect of economic activities, instead of promoting strong competition between neighbouring settlements.
- The investments (and their sites) shall be located so as to be easily accessible; they will have the least possible environmental (or landscape aesthetic) impact.
- Sharing the income from industry tax for joint-planning.
- Shared, effective organisation of the common employment market.
- Co-operation and synergies instead of competition: common representation when competing for sites – even as far as sharing local tax incomes.
- Reorienting transport networks and infrastructures so that the main places of employment shall be accessible from the residential areas, primarily by public transport.
- Protection of valuable natural and agricultural areas.
- Restriction of retail zones around the city (shopping centres), renewal and strengthening of the commercial function of the city centres.
- Increasing opportunities to work from home.

The co-ordinated, moderate enlargement of residential areas
Aspects:
- Adapting the transport networks, and public utility infrastructures to the residential areas.
- Enlargement along rail-based public transport axes; joint-development.
- Protection of sites of natural value and valuable agricultural areas.
- In order to protect the quality of the residential environment, securing green and open spaces that subdivide residential space; selection of sites promoting compact city development.
- Favouring the rehabilitation of the existing residential areas, reuse of abandoned and brownfield sites.

Strengthening the regional energy system and water management
Aspects:
- Increasing the proportion of local, renewable energy sources within the urban region, keeping closed cycle energy systems within the region.
- Local-regional public utility systems and waste water management.
- Strengthening different aspects of sustainability, for example use of renewable energy sources, supporting water conservation.

– Giving preference to decentralised energy management models, making use of the development and employment possibilities offered by local renewable energy sources which can contribute to the strengthening of the region's economic vitality and to the development of local society's awareness and self-sufficiency.

Protection of agricultural areas

Aspects:

– Protection of quality soils.
– Maintenance and reservation of strategic agricultural lands (in order to secure local food supply).
– Helping the creation of local commercial relations between the city and the surrounding agricultural areas.

Joint organisation and establishment of public services

Aspects:

– The spatial establishment of certain public services, optimalisation of their accessibility (with public and sustainable alternative transport) in close coordination with transportation.
– Urban regional institutional co-operation for the division of tasks and for financing.

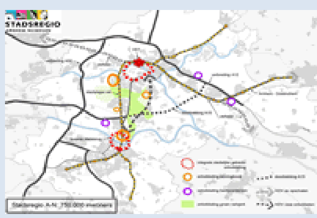
Planning of agglomeration transport systems

Aspects:

– Preference given to public transport networks. Priority of the rail based transport (tramway, suburban train).
– Bicycle and other alternative transport networks (including those internal network elements that connect larger units, including parts of the urban transport axes).
– Intermodality, development of the P+R, and B+R systems.
– Support for the establishment of the polycentric structure, strengthening transversal connections.
– The lines of the network have to connect the main functional areas (workplaces, living areas, recreational areas); however, areas where construction is not planned need to be respected for their ecological, agricultural or recreational functions.

Urban regions: A new level of governance in The Netherlands

In The Netherlands there was a central decision after the 2nd World War that they will not continue strengthening the big city centres but start a 'spread-type' of development across the whole country; this means that growth was directed towards the smaller cities. Thus they intend to create a more civilised version of the urbanisation of the last 50 years or more. There is a community consensus on this topic; for the past 50 years the compact city and compact development has been a national target in The Netherlands (this is understood as less than 35 person/hectare population density; moreover, developments should be oriented towards the existing railways and, furthermore, polycentricism as a stated objective means that further growth and development is oriented towards the smaller centres).



In order to strengthen a more balanced development the urban regional level was introduced as an experience next to the existing three administrative levels (the real administrative levels are the national, county and local levels), and seven urban regions were created. Although the role of the regional government (urban region) is limited, it has emerged as a successful partnership. The city region of Arnheim-Nijmegen, with 720.000 residents, is a good example of this.

The urban region contains 20 municipalities, and was created to enable co-operation in the following areas: economy, territorial planning, infrastructure, public transport and climate policy. A good example of consensus-based decision making is how the growth limits of the cities were indicated, taking both local and regional interests into consideration. Every municipality determined the boundaries of its own growth and the limit of the built-up area (new constructions may be determined within this without restrictions), and beyond these limits no development is allowed.

New constructions could be built on the condition that 50% is 'affordable' construction, earmarked to be a rented house or self-owned, valued below 70.000 EUR. The urban region is successful due to enforcing simple and affordable (smart) growth.

4.5. ESTABLISHMENT OF CLIMATE-FRIENDLY URBAN PUBLIC SPACES

Urban public spaces include many kinds of areas, for example, street network, playgrounds, public squares, public parks, 'wild' areas, water surfaces.

Public spaces play an important role city life:
- Public spaces are the sites of community life.
- Public spaces render character to the city.
- Public spaces strengthen the city from an economic aspect.
- Public spaces protect the environment.
- Public spaces ensure sites for culture.

Figure 9: Shading of public spaces in Brussels

Considering climate in planning already existing and newly established public spaces

Redesigning and establishing public spaces has, on the one hand, a mitigation effect, if they include a sufficient area of green space, and energy conservation is also considered. Should city-dwellers really use the well-designed public spaces and there is an increasing focus on an environmentally-friendly lifestyle, the use of environmentally-friendly transport methods (e.g. cycling, walking) can be expected grow, which also reduces emissions.
However the different aspects of adaptation must also be taken into consideration (e.g. drainage of sudden heavy precipitation, adaptation to heat waves). When starting to plan new public spaces or transforming existing ones.

Key aspects:

- City-dwellers are expected to spend more time outdoors due to warmer summers and increasing temperatures. All there require the **shading** of public spaces. Trees and plants have an special role in ensuring shade in squares and streets and numerous architectural solutions can also be applied (e.g. installation of arcades). Naturally, architectural solutions also have to take enhancing the positive effects of winter sunshine into consideration). We can ensure appropriate **seating and resting places** for people in public spaces by installing more street-furniture.
- Climate change raises the importance of **water**. In public spaces and playgrounds the number of wells and lavatories has to be increased as well as fountains and larger water surfaces which cool and improve the microclimate. Water conservation solutions must be chosen for irrigation of trees and plants in public spaces, and every effort has to be made for collecting and utilising rainwater. Enhancing the **permeability** of covered surfaces (e.g. use of surfacing with small elements applying permeable jointing instead of asphalt, use of crushed stone) facilitates the drainage of precipitation. The importance of plants cannot be emphasised enough, as areas covered by plants greatly facilitate water drainage; furthermore they significantly improve the microclimate by evapo-transpiration and evaporation.
- Adequate **shelter** must be provided against storms, sudden rainfalls and wind blasts for people being outdoors: these functions are provided by trees as well as built elements such as roofs.
- Also, **material use** has to be adjusted to the changed weather conditions. Besides the total lifecycle of the used materials, the material and energy demand of their manufacturing and

disposal has to be taken into consideration. Materials used on surfaces must be selected to ensure minimal heat absorption capacity for the sake of reducing the urban heat island effect. In this respect white and light surfaces – except for walking surfaces – are more desirable, than grey and dark ones. When operating various facilities care must be taken to utilise energy conservation systems and renewable energy resources.

- The natural ventilation of cities and the drainage of precipitation are supported by ensuring an appropriate **public space network**. Suitable planning of streets and public spaces, as well as footpaths and bikeways, encourage the spread of more sustainable means of transport.
- Enabling **accessibility** to public spaces and green spaces further strengthens the possibility of achieving the desired social and environmental goals; it is important that these really are accessible for urban-dwellers – even within walking distance. A good example of this is holding local markets in urban squares.
- Special attention must be paid to safeguarding the historical heritage of public spaces, as well. In historic gardens (which in many cases have become public parks over the course of history) and in historic public spaces, previously dismantled fountains should be replaced, not only because of their aesthetic value, but because of their clear microclimatic effects; other water surfaces, which are an element of garden composition, and drinking wells should also be restored. Moreover, the negative effects of climate change have to be mitigated by landscape architectural tools. When restoring garden compositions, the original types of plants should be planted anew; however, the effects of climate change and especially those of the urban microclimate must not be left out and consideration has to be paid to this when selecting plant varieties.

4.6. INCREASE AND DEVELOPMENT OF GREEN SPACES

According to certain forecasts, growing urbanisation is going to result in an increase in urban infrastructure and the spread of residential areas in the coming decades, as a consequence of which green spaces will be reduced and their fragmentation will increase. At the same time, the improvement in the quality and quantity of urban green spaces has growing significance in Europe; as climate change affects cities, green space improves the liveability of the cities and decreases suburbanisation tendencies. Instead of the principle 'Move to the green' the principle 'Let's bring green to the city' has to be implemented.

When an urban authority elaborates its own green space policy, the external benefits of green spaces which are difficult to quantify in terms of money, also need to be considered. Those benefits are well demonstrated by the fact that in many cities – despite their higher prices – real estate designed with a high proportion of green space is the most sought after.

4.6.1. Significance of urban green space from an urban climate perspective

Urban green spaces are important from many perspectives - urban-ecological, social, recreational, urban structural, aesthetic and economic. Favourable effects on the local climate are also manifold:

- Cooling effect due to evapotranspiration, evaporation and shading, reduction of urban heat island effect.
- Modification of solar radiation conditions and heat budget through reflection and absorption of sunshine.
- Improvement in air quality due to oxygen emission and increase of moisture content ('natural air-conditioning'), binding and filtering of airborne particles and pollutants.
- Sequestration of carbon dioxide.
- Ventilation effect, windbreak.
- Urban green spaces help store rainwater.

These positive effects can only achieve their expected impact if the green spaces are healthy and of a suitable size. Not only the proportion of green space is significant, but also their size, form, number, distribution and connection within the territory of the city. In ideal cases green spaces create a harmonic network, a green pattern. The state of the plants' health, as well as the quality of the planted areas and how well maintained they are, fundamentally influence the realisation of the above favourable effects (URGE Project). In respect of climate change, green space elements play an essential dividing, separating and connecting role in urban structure.

Effects of climate change on urban green spaces

The changed climate has a great impact on green spaces and natural systems. In the case of urban green spaces, the following main effects can be observed:

– Warmer and drier summers increase the irrigation demand. Plants with shallow roots (e.g. lawn) are more vulnerable. In periods of drought or water shortage there are less possibilities for irrigation, thus retention of precipitation is of primary importance.
– Pests and pathogens characteristic of warmer climates are spreading further afield. As they are relatively unknown and non-endemic, greater damage is expected.
– In hot summers residents will presumably use urban green spaces more intensively; while this increases their importance, it simultaneously increases pressure on the space.
– As a consequence of the above, maintenance expenses for green spaces will increase; this can be counterbalanced by correct planning solutions, water conservation management, and choice of suitable plant varieties. Spaces should be established which are able to bear the pressure from increased use, thus sparing the most sensitive green spaces.

Questions concerning mitigation and adaptation of green spaces

Urban green spaces are primarily essential from an adaptation perspective; however, they play a role in mitigation, too. Any urban green space – regardless of form, size and type – supports the **adaptation** of cities to the effects of climate change. **Open spaces** within cities serve adaptation more efficiently than the greenbelt around the city. These areas ensure shade, facilitate the filtration of precipitation and improve the microclimate. A proportional increase in urban density ensures the provision of these areas and prevents a decrease in green spaces. Additionally, green spaces contribute to the settlements' flood protection. Adaptation measures have to pay special attention to avoiding an increase in greenhouse gas emissions (e.g. maintaining lawn requires energy input).

An increase in green spaces contributes to **mitigation**, as well; plants clean the air and absorb CO_2 from the atmosphere; their cooling effect reduces the demand for energy-intensive, active cooling such as air-conditioning appliances. Green spaces shape the inhabitants' attitudes, too; an increase in walking or cycling reduces the use of cars. The gradual spread of community gardens also decreases the demand for energy for transportation.

Paying attention to disadvantaged groups

Residents living in cities or districts which are socio-economically disadvantaged are generally more vulnerable to the effects of climate change. Usually less trees and green spaces can be found in these districts and as they are difficult to reach, their environmental impact – for example through transport – is higher. As a consequence of these factors air quality is generally poorer and fewer tools are available for adaptation to climate change. Therefore local governments must pay increased attention to the establishment of green spaces in these districts.

4.6.2. Various possibilities for urban greening

It is the responsibility of city authorities to encourage and increase the establishment of green spaces in the already existing urban fabric, as well as in newly built-up areas.

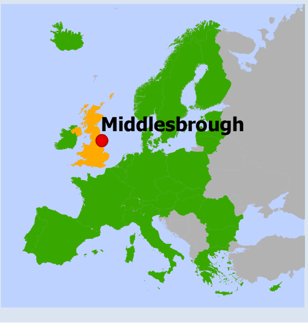
Regulation to encourage the establishment of green spaces

Adequate national, regional and local regulation and planning policies are of fundamental importance for the efficient planning, management and development of green spaces. Similarly, the implementation of these policies requires adequate legislative and regulatory tools. Examples include time-tested solutions such as the use of fines, imposed for misuse of public and green spaces, or the stipulation of a minimum ratio of green space, both common tools in planning regulations. Green space planning has to be harmonised with other planning processes (e.g. traffic, public utilities planning). In the course of elaborating green space policies and green space plans, priority must be given to involving stakeholders (e.g. residents, investors, entrepreneurs, non-profit organisations).

Proposals for greening the urban fabric

The following examples refer to the greening of existing urban areas and areas to be newly constructed; these refer to both public and privately-owned areas. Green spaces, amongst other things, play an important social role. They are the hub of community life, and by involving the local community, the residents can also play a role in the maintenance of the space. Green spaces fulfil multiple functions simultaneously; the same area can be useful in urban flood protection, while also being a remarkable community space.

- **Planting of avenues of trees and rows of plants** on public space along the roadsides, which are able to withstand the air pollution from traffic as well as absorb the pollution. Transport, utility and public space plans must ensure enough space for the roots of the vegetation. For example, building underground garages prevents trees being planted at a later date. During planning, the maintenance costs of green spaces also have to be considered.
- Protected urban areas with a high ecological potential are also valuable due to their CO_2 sink capacity; these must be given a greater level of protection. The level of protection given to valued areas must be reviewed, and the necessary protection given to valued natural areas and urban woodlands.
- **Planting up traffic spaces** while reducing paved surfaces (it needs mentioned that maintenance of the intensively grassed surfaces between tramlines demands a high energy input).
- **Local government leads by example**: expansion and renovation of green spaces in the gardens and courtyards of public institutions, schools, hospitals and in public cemeteries.
- Establishing **roof-gardens** is a welcome initiative; however, this should not result in the reduction of green spaces or an increase in construction density. Extensive roof-gardens are favoured over intensive **green-roofs**. Adequate planning and expertise is essential for establishing roof-gardens.
- Besides improving air quality, green façades provide, on the one hand, some protection against façade damage caused by heavy rainfall or hail and, on the other hand, they have a positive effect from a building energetics' perspective. Furthermore, they favourably influence the microclimate of streets which have little green space, especially in the summer months. More opportunities exist for greening **façades**. In this publication we recommend those methods which incur lower installation and maintenance costs, e.g. planting climbing plants.
- All over the world **urban farming and gardening** are gaining popularity. **Community gardens** are advantageous not only from an environmental point of view but they also play a role in strengthening community resilience. An outstanding initiative is the greening of apartment blocks by the creation of **courtyard gardens**.



Middlesbrough, urban farming

Middlesbrough is located on the South bank of the River Tees in the North-Yorkshire county in North-West England. The Middlesbrough Urban Gardening Project's aim is food production and urban farming in urban public spaces. The programme started in 2007 as part of the 'Designs of the time 2007' project, supported by Middlesbrough Council, non-governmental organisations and other partners. The partnership began in 2007 with funding of 8.8 million GBP. In 2007 it won 4.1 million GBP in funding from the Healthy Community Challenge Fund.

The project implemented the following activities at 264 sites: use and development of distribution sites, professional horticultural training for the community, urban catering, setting up industrial co-operatives dealing with local food, and setting up a food policy council. The programmes offered residents the opportunity to work together, grow plants, become acquainted with local food producers and gardeners. In the first year more than 2,500 people tried the urban produce and 8,000 participated in the programmes. More than 80 groups, schools and other organisations showed interest in the programme and participated in the campaign 'from the soil to plate'. With the permission of the local council, the Urban Farming Teams could plant extraordinary plants and seeds in a dedicated area in the city's main park. The project aims to make people aware of the significance of 'food miles' (the journey food takes from the production site to the consumer) and local products, furthermore to enable experimentation in efficient, multi-functional green spaces. The long term goal is for Middlesbrough to become self-sustaining, and the city, as well as other post-industrial settlements of Great-Britain, to participate in the creation of a sustainable future.

Contact:
Contact persons: Ian Collingwood, Charlotte Rutherford
E-mail: charlotte_rutherford@middlesbrough.gov.uk
Web: www.dott07.com/go/food/urban-farming
www.cabe.org.uk/case-studies/middlesbrough-growing

Budapest, GANG-group

The Hungarian capital plays a central role in the country. In this metropolis, with its population of around 2,000,000, various environmental problems are accumulating; over-crowding, air pollution, lack of green space. In the 1950s-60s, apartment houses in the inner city had their courtyards paved, often to be used for car parking. Lack of green space is often a problem in these areas, and this has led to many positive initiatives for improving residents' quality of life.

GANG was founded by a group of friends in autumn, 2006. Dealing with creating and creatively transforming gardens, the group began its activity in the inner city of Budapest, where they successfully renovated three gardens and courtyards together with the houses' inhabitants. After these successful initiatives, more apartment houses in the inner city turned their courtyards into green courtyards.

Taking the inhabitants' ideas into consideration, the group elaborated garden-layout plans, consulting the stakeholders and organising residents' meetings. The gardens were created through the residents own efforts, digging and planting during weekends. Funding was obtained for plants and soil, and the projects were supported by other non-profit organisations.

GANG's aim is to create a city where community-life thrives and it is possible to lead a close-to-nature lifestyle. To achieve this they would turn more and more Budapest courtyards into gardens, creating a common open-air living room, and helping the houses' residents take an active part in forming their own living space.

Contact:
E-mail: azudvar.eletrekel@gmail.com
Web: http://gang-gong.blogspot.com
(Photo: Z. Molnár)

- As a result of climate change, **maintenance and watering costs** increase, drawing attention to the importance of water conservation. It is desirable to retain and use precipitation, and in the longer term, to utilise grey-water in irrigation. Reducing sealed surfaces and increasing the permeability of surfaces allows makes water available for vegetation.
- Local government can help residents' and local businesses' efforts to green the cities by providing **guides and financial support**.
- **Composting** the green waste that is produced by the green spaces considerably reduces the overall quantity of waste; this opportunity is not only possible in areas with detached houses and gardens.
- Local authorities must **communicate** with the population about their actions on climate change. The population must be involved in the planning and management of green spaces. At the beginning this may seem a nuisance to the local authorities but the costs incurred shall be recouped by the increased acceptance of the plans and reduced maintenance costs.

The following factors should be considered when establishing new green spaces

- Considering bio-diversity in plant variety, is important in cities, too. Multi-level, larger green spaces are more resistant, the natural processes perform better here. This is an advantage from the point of view of garden maintenance and also has economic benefits. Urban flora is characterised by the high proportion of non-native plants. As a general recommendation it can be said that from an environmental sustainability perspective, it is preferable to plant vegetation able to adapt to a changing environment, keeping in mind the potential impacts of climate change.
- From a climatic perspective larger foliage is favourable; different types of tree have a different pollutant-binding capacity.
- Maintenance costs of green spaces: maintenance of intensive lawn-surfaces (e.g. owing to fertilisation) has relatively high GHG-emissions, balances out the positive effects. Plants growing in containers and flowerbeds need lots of attention; their maintenance is expensive.
- While selecting varieties, predictable weather conditions and their climatic effect must be taken into consideration. Drought-hardy plants are less favourable from the aspect of adaptation, although they need less watering. For the sake of watering it is important to retain precipitation locally.
- The cooling effect of green spaces varies according to the structure of vegetation: the cooling effect of large, contiguous areas is stronger than smaller areas. Thicker green surfaces have a greater cooling effect.
- In order to decrease the intensity of the heat island phenomenon, it is important to pay attention to preserving or increasing the proportion of green cover when creating or adapting green spaces.

4.6.3. Establishment of adequate management for green spaces

Development and maintenance of urban green spaces requires adequate city management, and maintenance costs have to be taken into consideration during the planning period. Decision-makers often regard urban green spaces as an expensive urban area not bringing financial benefit. They do not consider the significance of the intrinsic value of green spaces, they do not calculate with the services of the offered ecosystem (e.g. climate regulation, maintenance of biodiversity, cultural, recreational and aesthetic services) and with its other social effects. It is generally accepted that multi-functionality contributes to the maintenance of a great number of urban areas. In the case of green spaces this could mean, for example, the organisation of events, concerts, and markets depending on the capacity of the area. Revenues received in such a way must be spent on the maintenance of green spaces.

4.6.4. Green areas surrounding the city

Due to the built-up nature of larger cities, residents are only able to satisfy the greater part of their need for green space in areas out of the city, which often don't actually belong to the city's administrative area. Among the natural areas around the cities, forests play a primary role. Peri-urban forests have an important mesoclimatic function – e.g. moderation of heat fluctuation, filtering of pollutants – while they also play a decisive role in satisfying the inhabitant's environmental and recreation needs; these are constantly increasing due to climate change and the growth in healthy, environmentally-sensitive lifestyles. This lifestyle requires opportunities for open-air and green space recreation, like walking, day-trips, cycling, other outdoor sports activities. At the same time, it is important for inhabitants to be able to satisfy these types of needs in an environment near to the city, i.e. without greater need for travelling.

That is why the comprehensive planning and management of peri-urban green spaces is of primary importance; both the urban-climatic (mitigation) needs of forest areas and the ecological-recreational needs of society (adaptation) need considered. In addition to the local authorities' role in coordinating and creating incentives, local farmers, entrepreneurs, and forestry authorities also have a significant role to play, and co-operation with them is a basic criterion for success.

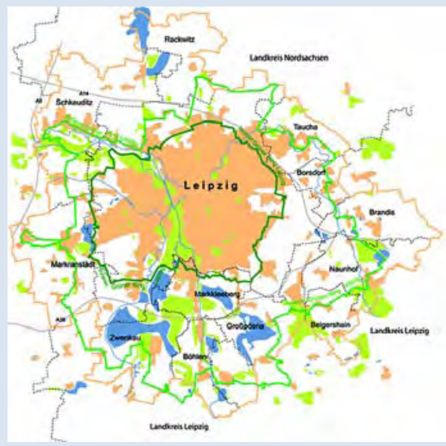
When developing or establishing peri-urban green spaces, forests and other non-built-up areas, the following factors need considered:

- **Common city region level strategy** for peri-urban green spaces; it is recommended to develop a determined strategy in respect of ecological networks and connecting recreational sites.
- Consideration of comprehensive **climate protection** factors in the course of planning peri-urban green spaces, and in co-operation between the city, neighbouring settlements and relevant authorities.
- In the 10 to 50 km zone around the city, **recreational-ecological functions** are to be given preference to production (lumbering) in forest management. This has to be guaranteed in the land-use plans.
- The **aesthetic quality of the landscapes** should be protected and develop in a systematic way.
- Plans regulating land-use must also be elaborated jointly, or at least in close coordination.
- Establishment of **open space recreational sites**: establishment of forest-fields with a recreational and training-demonstrational function (e.g. forest parks), creation of other open areas, nature-like sports areas, sites.
- **Polycentric** networks should be strengthened also for peri-urban green spaces. Besides helping the ecological networks, developing and strengthening green networks - perhaps even greenbelt - also helps ensure that recreational use has a more even spatial distribution, in closer proximity to residential areas.
- Peri-urban recreational sites have to be **accessible in a sustainable way**, possibly by rail-based community transportation or by cycle.
- Control of construction based on the joint city region strategy.
- Community access must be ensured in peri-urban green spaces – with consideration to the carrying capacity of the environment.

Leipzig, Green Ring

With its population of half a million and its territory of 297.6 square kilometres Leipzig is the largest city in the Saxon Federal State. It is located in the Eastern part of Germany, at the junction of the Rivers Pleisse, White Elster and Parthe. The city, founded in the middle-ages, has been a trade and cultural centre for centuries. Since the mid 1990s, in the framework of developing green spaces, a deep and diversified co-operation has developed in Leipzig. The Green Ring (Grüner Ring) Project, realised between 1996 and 2008, was implemented as a result of the co-operation between the settlements around the city, two counties and environmental organisations.

The Green Ring Project was implemented through 26 key projects in the framework of landscape maintenance, water development and tourism. Developments were carried out on the following areas, according to an environmentally-friendly technologies' road plan: renewable energy resources, noise pollution, environmental-awareness education, biotechnology, environmentally-aware construction industry. Within the framework of the project deserted, open-cast brown coal mines in the surroundings of Lepizig were recultivated and brought into the green spaces development programme; furthermore, the woodland within the area of the Greenbelt was increased. Within the framework of the project two regional bicycle routes were also built, the 65 km long inner green ring, leading along the boundary of Leipzig as well as the 160 km long external green ring, connecting the settlements around the city. Among other things, the development has led to an increase in the value of the environmental landscape and quality of life in the region of Leipzig.



Contact:
Contact person: Heiko Rosenthal
Geschäftsstelle Grüner Ring Leipzig,
c/o ISIP Weiterbildungsgesellschaft mbH
Rosa-Luxemburg-Straße 20, 04103 Leipzig
Phone: 0341 25 35 650
E-mail: grl@isip-weiterbildung.com
Web: www.gruener-ring-leipzig.com

4.7. REHABILITATION OF BUILT-UP AREAS

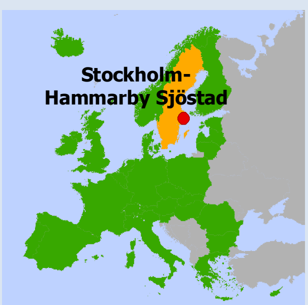
From a sustainable urban development and climate protection perspective it is of primary importance to strengthen the regeneration of areas with devaluing functions; to undertake new developments in already built-up areas, and not in those which are not built-up or have less intensity. In a great number of cities such already built-up, old districts can be found; the rehabilitation of these cannot be avoided due to the high proportion of obsolete, old buildings and the run-down condition of public areas. Out-of-use brownfield areas and extended rust belts cause further problems in the urban fabric; brownfield areas are unused or underused former industrial or military sites (such as barracks), which are in poor state, burdened with environmental pollution and cause a settlement structure problem. The well-thought out renovation of these areas is essential, taking into consideration environmental, social and economic aspects, which is useful from a climate protection perspective, too.

- Re-use and rehabilitation of these areas is always favourable as they do not require any further occupation of land. Their renewal reduces the development of peri-urban areas and urban sprawl, which generates much greater energy consumption and transport needs.
- These old districts are generally characterised by high density and diversity, therefore the mobility needs are lower here and residents use public transport and environmentally-friendly kinds of transport more frequently. All these are in harmony with the concepts described in the section on climate-friendly urban structure.

- The energetic characteristics of older buildings are generally inferior; therefore their renovation results in remarkable savings.
- The integrated regeneration of already developed areas contributes to the rejuvenation of traditional pedestrian precincts and to the prosperity of local commercial life; this is also better for the environment than shopping by car in the peri-urban big shopping centres and leisure-centres.
- Brownfield areas are generally polluted. The often costly remediation of these sites is absolutely necessary; from a climate protection perspective investments that prevent the pollution of groundwater also serve to protect increasingly scarce drinking water resources.

The **climate-friendly regeneration** of built-up areas implies the following activities:

- Establishment of attractive, secure, liveable and green districts, which are able to compete with new, peri-urban and greenfield buildings.
- Elaboration of programmes for the renovation of transition zones, regeneration of run-down districts, remediation of abandoned brownfield (industrial, transport) areas.
- Shaping local government housing management policy in respect of old districts, with the aim of letting unused private and municipal apartments, setting up and running a social housing system for deprived individuals.
- Municipal incentives and support for the implementation of energetic aspects in the course of regeneration.
- Municipal support for the local economy, as well as professional and financial assistance to local entrepreneurs and incentives for co-operation. As a result of this – for example – the transport kilometres and the GHG emissions will decrease.
- Realisation of the above activities requires moving substantial financial resources; they can usually be implemented over the space of many years, within a programme framework. Local government has a directing and leadership role; their task is to co-ordinate the various participants.



Hammarby Sjöstad – a unique environmental project in Stockholm

The basin of Lake Hammarby is in the Southern part of Stockholm, the capital of Sweden. Until 1990 it had been an industrial area with highly polluted soil. In 1990 the city's leadership drew the plan of a new subcentre around the lake. The strategy was to build an environmentally and architecturally modern, and eco- friendly city. The plan is that by 2015 11,000 residents and other buildings have to be constructed. 80% of the programme has already been realised, but once it gets finished over 11,000 people will have homes in Hammarby.

Hammarby has architectural solutions of the 21st century. Modern flats and service buildings cater all needs of the inhabitants. The district has many green surfaces, and parks where people can do sports or enjoy simply their spare time. Not just the parks, but the overall space is bigger as well in Hammarby than in other parts of Stockholm, here the space between houses and the street has to be at least 15 m^2. Local transport consists of several tram routes, and cycle paths. It is important that travelling happens in a climate-friendly way. Hammarby Sjöstad has integrated environmental solution along structural novelty. The district has its on system that consists of renewable and sustainable energy, recycling waste and water usage.

Goals related to the adaptation to the climate change:

- the entire heating supply shall be based on waste energy or renewable energy sources;
- district heating connection with exhaust air systems;
- solar cells and panels to ensure extra electricity and water

heating. 1 m^2 cell will produce 100 kWh/year energy;
- consumption of biogas; usage of Hammarby's waste water as fuel in vehicles.

Hammarby Sjöstad can be an excellent example for cities, which want to create a modern and eco-friendly district of their city also a solution to improve eco-cities in many ways.

Contact:
Lugnets allé 39, SE-120 66 Stockholm, Sweden
Phone: +46 8 522 137 00
Web: www.hammarbysjostad.se
E- mail: info@hammarbysjostad.se

London 2012 project – brownfield investment

London was elected to be the host of the Summer Olympic Games of 2012 on 6 July, 2005 at the 117th session of the International Olympic Committee in Singapore. The central site of the Olympic Games in London will be an area of 2.5 km^2 in the valley of the River Lee, which functioned earlier as industrial enclosure area and landfill.

The site for the grandiose event will be ensured by the rehabilitation of the lower valley of the River Lee. The whole region may profit - even after the Olympic Games - from the revitalisation project, which requires substantial resources. In the National Brownfield Strategy prepared by English Partnership, the underused brownfield areas were divided into four categories, out of which the area serving as the site of the Olympic Park belongs to the sites of category 3 and category 4. In these areas rehabilitation and rejuvenisation are possible only with intensive state intervention. This is due to the high costs of environmental remediation, the necessary development of the utilities and transport network, and unsettled land ownership issues.

The London bid promised new facilities, the renovation of the already constructed buildings and temporary investments, including, among others, the Olympic Stadium with a capacity of 80,000, the Wembley Stadium, and the Olympic Village with a capacity of 17,320 beds. According to the plans, the Olympic Village will be transformed into one of the largest European city parks, and the buildings will be turned into residential homes in the future. In addition, the bid committee promised to develop the public transport, which means, above all, the extension of the West-London line of the subway network and the development of the Docklands Light railway.

The budget of the Games will presumably be around 9.345 billion GBP, including the development of the Eastern part of the British capital. Building the sites and the development of the infrastructure and the area of the Olympic Park will be financed from public money.

Contact:
London Organising Committee for the Olympic Games/London 2012
One Churchill Place, Canary Wharf, London E14 5LN
Phone: 020 3 2012 000
Web: www.london-2012.co.uk

4.8. KEY INSTRUMENTS FOR SHAPING URBAN STRUCTURE

In shaping climate-friendly urban structure, it is of key importance that the goals formulated in the plans and the identified area structures can actually be implemented. The settlement land-use plan is a significant tool (settlement-level physical planning), however, in shaping urban structure the key issue is how stakeholders can be successfully influenced, as a considerable part of the area is generally privately owned by companies and citizens. Today, it has become clear from our experience in Europe

that under market economy conditions preparing land-use plans and related regulations is not enough to allow a merit-based development of the settlement's structure.
It is vitally important to successfully influence the market actors and also to convince the citizens. Involving the stakeholders and using a participatory planning approach is of fundamental significance. In addition to the involvement of the population and market actors, **establishing ongoing partnerships** with the local-regional public institutions can also be useful, primarily with high schools, universities and research institutes; this points to the need for more varied, creative tools which embrace not only physical planning issues.

Main tools used in shaping urban structure and land-use:

- **Regulatory-type solutions:** it is worth emphasising the following tools for use in territorial and physical planning; the application of *absolute restrictions (*zoning limitation, building licenses, development moratoria); '*transferable development rights*'; other, *not absolute restrictions*, for example, *shift of development costs* to the developers.
- **Land-property related opportunities**: purchase of lands owned by the state or by the local government has a great effect on urban spatial structure and influences the way in which urban areas grow. A further interesting solution is the possibility of founding new cities, a question that regularly comes up in many countries.
- **Incentive-based solutions:** non-desirable investments are decreased by financial or non-financial interventions. These include *development, capital and real estate taxes*, but also the adequate establishment of *various incentives of brownfield developments* or *housing support systems* or even *state support of local development zones*. Non-financial interventions worth highlighting include *increasing the attraction of downtown areas* or *regionalisation of urban services*.
- **Solutions concerning governance:** *many tools can be included in this category* from *the informal* (voluntary, bottom up) *co-operation of local governments or other market and social actors* through promotion of *co-operation activities across administrative boundaries, to the reorganisation of public administration*. Furthermore, it is worth mentioning the application of various tools of *demand-oriented management* (urban marketing) and the implementation of '*good governance*' on a territorial basis.
- **Possibilities for awareness-raising***:* such 'soft' interventions include shaping public opinion through awareness-raising, by providing information on the effects and consequences of urban sprawl. *Information and educational campaigns* also belong to this category; however it is also worth emphasising the *necessity of building a local-regional identity*.

4.8.1. Plans

The aims and concepts shaping a city's structure are reflected most clearly in land-use plans and local building regulations; these best serve their function if they are simultaneously able to successfully realise the comprehensive climate protection strategy and goals introduced in Chapter 2.

In Europe the regulation of planning is purely national competence, and hence the planning systems are very diverse. Nevertheless, in terms of goals and duration, certain types of planning are implemented in almost the same form in most countries. An urban development vision, a strategic concept document, a more general structural zoning plan and a detailed land-use regulating plan generally exist in most states, and are in many cases supplemented by programme plans supporting the implementation of the actual urban development goals. In some countries (England, Switzerland and Sweden) combined, comprehensive plans serving these objectives are elaborated in an integrated manner. On the basis of the integrated urban strategy the closer and clearer relationship between the development plans and the land-use plans increases the efficiency of their implementation. In several European countries, besides the traditional, zoning regulation and prescriptive planning practice, there is a shifting tendency from detailed **regulation** towards **directives** and **investment orientation** (generating demand). At the same time, the ability to consistently and concretely enforce the regulations is also of prime importance

Transparency and clarity are of primary importance in planning; however, in many countries planning regulations are too complicated for the public, and there is a risk that they bind the hands of local authorities in such a way that they restrict the enforcement of strategic goals. Instead of so many regulations, it is advised to move towards **clearly formulated directives** in order to efficiently support settlement-level planning.

Urban structural vision: Do not get lost in the details!

When planning strategically, spatial use should also be enforced in the land-use plan determining the placement of functions. Therefore it is useful to elaborate a **conceptual spatial structure vision** - as part of the integrated strategy - prior to the detailed land-use plan, which indicates the large structures within the settlement, as well as envisioning the desirable character of the main zones and sectors without, however, going as far as to set actual parameters. Through this, the actual form of the spatial structure concept and the settlement's long term plans and goals become clear to the population and business actors.

The strategic nature of these plans means that, besides establishing the functions and land-use, the **financing and schedule** of implementation should also be elaborated, project leaders should be nominated for each target, and hence a kind of **programme** is created for shaping the spatial structure assigned in the plan.

Nijmegen, strategic functional urban structure vision in a plan

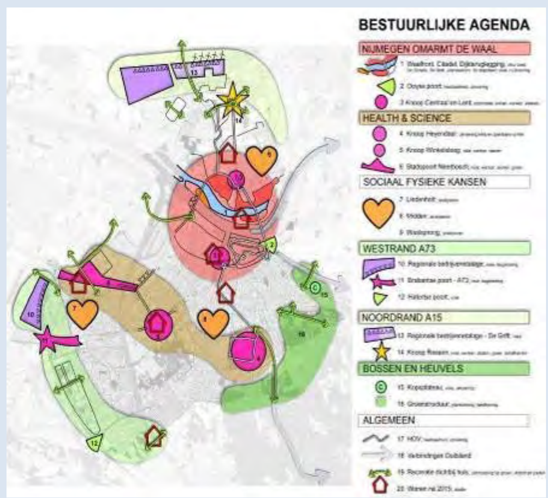
Nijmegen is a city with a population of 160,000 in the South-East of Holland, near to the German border.

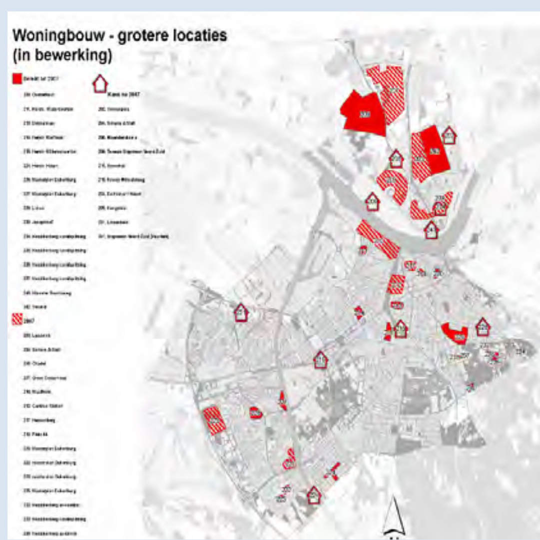
The spatial structure vision of the city (Kansenboek – 'Book of Possibilities', 2007) broadly determines the sites of the desirable functions within the city. The simple, clear form makes it possible for the public to have access to understandable information concerning ideas about the future of their city.

The second figure shows one of the thematic plans from the 'Book of Possibilities' regarding the so-called 'strong districts'.

Source: City of Nijmegen Local Government Office

Contact:
Municipality of Nijmegen, Directie Grondgebied en Directie Inwoners p/a Stadsontwikkeling, bureau Planologie en Ruimtelijke Ordening,
Web:
www2.nijmegen.nl/wonen/projecten/visies_op_stadsontwikkeling/Kansenboek
www2.nijmegen.nl, Ad van Dortmont, senior planner
E-mail: a.van.dortmont@nijmegen.nl





4.8.2. Local society's responsibility – Involving the people

Examples of successful European practice prove that if local residents regard the shaping of the town image, environment and the spatial structure of their own settlement as a public affair, this strengthens the efficiency of urban planning and consequently its efforts for climate protection. If this 'issue' becomes a public topic among the residents, it becomes an important issue for the elected politicians, too. Activities undertaken together at local level - bottom up initiatives - contribute to the long term success and liveability of the settlement. Considering one's own living environment as valuable, the feeling of togetherness, are values upon which top down initiatives may build. For these purposes local residents have to be made aware that they are also concerned and can shape local processes.

Successful community planning needs not only space and time but appropriate expertise and development techniques have to be drawn upon. The population can be activated by consistent use of flexibly chosen techniques and methods, such as community events, sports day, children's day, drawing competition.

Implementation of the following considerations helps **urban planning to become a public affai**r:

- The population must be made interested in participating in shaping its own place of residence with tuition, educational, community-building tools.
- The aim of community-building and development is for citizens to recognise their common interests and act as a local community, together; furthermore, it helps strengthen civil society.
- Through awareness-raising activities, citizens can become 'public or civil' individuals and think in terms of long-term interests.
- Full publicity, transparency of plans, planning and information have to be ensured.
- Investors have to recognise that they have to make planned investments which are accepted not only by the local politicians, but must also be attractive for the whole of the local community and correspond to their values.

Strengthening the control of civic society is definitely important; where settlement planning and climate protection is an properly handled public issue, the democratic role of the local society may be of key importance.

4.8.3. Transparent partnership with economic actors

In the course of urban development, and in shaping urban space, the will of private capital cannot be disregarded. Recently it has gained even more importance due to the significant cuts in the public budgets in most European countries. The involvement of private investors in urban development is important, but it must be involved in a way that the interest of the public is not violated. The local government should establish stable, predictable, and well-organised offers of areas, sites of development to interest investors, retaining some flexibility for possible negotiations. This offer of 'spaces' has to reflect the urban structure concurrent with public interest.

A widely-known and applied method of co-operation with private capital is the **PPP** (*Public Private Partnership*), the co-operation between the public and private sphere. In order to reach urban development objectives, so called institutionalised PPPs are created, such as **urban development companies**, in which public and private capital, public and private interests are represented equally.
In European countries **market-based tools** are increasingly used in settlement planning and development, and during the implementation of plans. The public sphere (the local government) is more and more a supervisor and coordinator of the processes, delegating implementation to well-operating market processes and automatism.

Numerous financial tools may be available for the local governments to orient investors and enforce public interests.

Development deals
'Deals' between private investors and the local government can be formalised in contracts. In this way local governments attempt to implement previously incalculable public developments by placing an unequal burden on developers. In big cities the introduction of a **normative infrastructural contribution** is useful, differentiated according to the character and location of the development, by which the investment's public dues can be calculated; this can provide a suitable basis for financing more expensive public investments.

Introduction of a market for development rights and development bonus system
The use of **development rights**, as known in the United States, is less widely used in Europe. A further example for co-operation between the public and private sphere is when the local government transfers its development rights to a project-company and in exchange for this the local government can determine terms and conditions. When the area is later sold, the community also participates in the profits.

Betterment tax - development and/or normative infrastructural contribution
Taxing the surplus value generated by community investments and public developments can facilitate financing, which can be realised with the introduction of the **normative infrastructural contribution** and the **increment value tax**. The increment value tax or duty **taxes the real estate/land value increase incurred as a consequence of the developments by members of the community,** by compelling the concerned owners to contribute to the costs of community development. An extended system of local taxes can influence people's space use - beyond construction and function installation (e.g. taxation of construction) – for example, by taxation of urban car use (e.g. parking and access) and by support of public transport.

Other area based selective taxes
With spatially selective taxation of buildings and land-use, the shape of the spatial structure of cities can be efficiently influenced, for example, for controlling urban sprawl or ensuring appropriate biological activity.

4.8.4. Communication and assistance relating to plans

Inhabitants intending to build, or even investors, consider land-use plans as a kind of restriction, and as a barrier to the implementation of their ideas. At the same time planning and regulation could render assistance, thus it can have a kind of **public service function**, as well.
Support given for adequate site selection and orientation of developments helps not only the builder or the developer, but by orienting the participants it supports the implementation of the plans. Assistance may include personal counselling (where to settle down, what can be developed), preparation of publications, information forums as well as the preparation of comprehensive and easily available information, or a direct information service supported by help with terminology. **Information services** may include not only planning documentation, but also data (real estate prices, environmental data, air, noise pollution, accessibility, etc.), various thematic maps and, of course, land registry records. Formulation and publication of local plans – both physical land-use plans and development plans – in a non-technical manner can result in an improvement in relations with the residents, as well as with the developers and potential investors. Becoming acquainted with and attracting developers must be supported by such publications, communication materials or even internet surfaces and interactive plans that are **available**, and understandable **for a wide-range of the public,** drawing their interest to the settlement plans.

BRIEF RECOMMENDATIONS

- Travelling and transport needs within and outside the city must be reduced, especially commuting; these needs have increasingly to be satisfied through networks of environmentally-friendly means of transportation (public transport, cycling, etc.).
- Establishment of a compact urban structure, in which interactions are intense, infrastructure utilisation, is efficient, transport distances are moderate and urbanised land-use is restricted.
- Urban structure must be divided by non-built-up areas, green zones, zones ensuring ventilation with regard to the climatic characteristics of the city and its surrounding, and the prevailing wind directions.
- Polycentric structure must be strengthened on regional and urban region level, as well as in the inner structure of the cities, by development of sub-centres (or equal centres) and shaping their relations.
- Urban public spaces should be extended and made climate-friendly.
- Urban green spaces must be extended and their quality improved, keeping in mind connectivity.
- Co-operation of the city and its surroundings, based on division of labour, must be strengthened in a way that avoids the rapid transformation of rural areas.
- It is necessary to create incentives so that an increasing proportion of urban food needs can be met by agricultural producers in the nearer and wider region, shortening the regional distribution chain.
- The intergrowth of the built up areas of settlements around big cities assigned for construction should be prevented.
- Urban sprawl must be moderated and controlled to prevent increased energy consumption, loss of spaces with ecological functions, or the many potentially harmful effects of commuting.
- In urban regions, it is necessary to have effective partnership between the concerned settlement, regional and national authorities, taking into consideration common sustainability values. Multi-level governance is also needed.
- Urban land-use policies have to consistently enforce strategic urban structural goals; a broad and transparent equal partnership shall be implemented between stakeholders, business actors and the local society alike.
- When implementing urban structure related plans transparent and efficient partnership with economic players and involvement of the local society is essential.
- The multiple functions of urban regions, their spatial structure shall be planned comprehensively and in partnership.

5. CLIMATE FRIENDLY URBAN TRANSPORT

One-fifth (19.6%) of carbon dioxide (CO_2) emitted in the territory of the European Union and 3.5% of global CO_2 emissions originate from transport. Additionally, unlike from other sectors, greenhouse gas emissions from transport have been continuously growing over the past decades; between 1990 and 2007 this increase was 28% in the countries (EU27 + EFTA4 + Turkey) participating in the work of the European Environmental Agency.

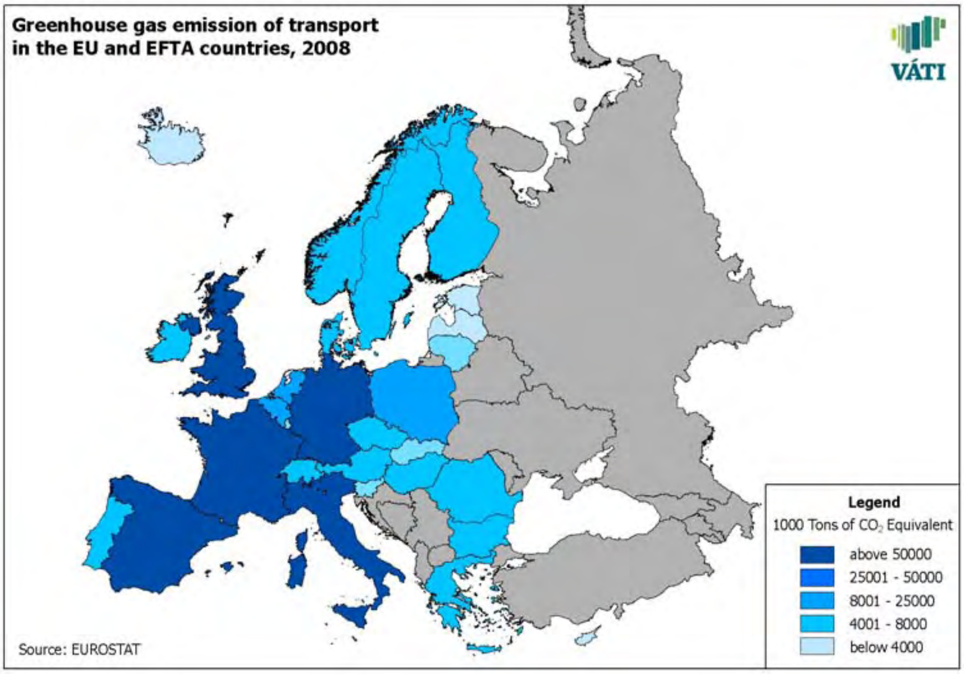


Figure 10: Greenhouse gas emission from transport in the EU and EFTA countries, 2008

Attempts to decrease greenhouse gas emissions from transport have been successful only in four countries (Bulgaria, Estonia, Lithuania and Germany) during this period. (EEA, 2010a) Within transport, road traffic is responsible for the highest share of greenhouse gas emission, nearly half of which (41%) is generated in the cities (UITP, 2006). Data indicate that the adjustment of the transport systems of European cities by taking climate protection aspects into account may significantly contribute to the success of efforts made to halt global warming. The implementation of the actions suggested in the following also improves the life quality of urban inhabitants because a truly climate-friendly urban transport system, through mitigating the demand for motorized means, leads also to a reduction in pollutant emissions and, consequently, to cleaner air, less noise and improved urban health.

Recognising the social, economic and environmental significance of urban transport, the European Union issued a green paper entitled 'Towards a new culture for urban mobility'. In this document, the major problems of urban transport are identified some relevant possible solutions are presented, and the question is posed concerning the potential role of the European Union regarding the topics raised. As an outcome of the consultation following the publication of this green paper, the Commission adopted its 'Action plan on urban mobility' in 2009 denominating concrete actions, as recommendations, for the cities in order to help developing sustainable transport.

Due to their comprehensive nature, planning, implementation and maintenance of climate-friendly transport systems assume the joint application of several (planning, regulatory, economic, technological and communication) instruments. Consequently, sustainable transport can be planned only in an integrative way and its implementation has to be in harmony with the development plans related to the entire city. However, it is practical, especially in the case of large cities, to prepare an urban mobility plan, the results of which can be utilised well in the integrated urban planning process.

The mitigation and adaptation possibilities affecting transport are varied in their costs. The modernisation of public transport may require enormous sums in a big city, while the carefully thought-out reorganisation of traffic or the promotion of pedestrian traffic may need some attention only. However, when estimating the costs it is always important to count in indirect expenses, savings by individuals due to the reduced traffic (fuel, maintenance of vehicles), the increase or decrease in the value of the affected properties, the change in additional expenses caused by noise, and most of all, the global impact of environmental emissions. In each case, these have to be established separately; therefore, in respect of the individual proposals, maximum the investment costs can be estimated in a generalised way; the final result is always decided locally. It may happen that because of the more substantial decrease in emissions, the replacement of the bus or tram fleet of a big city proves more beneficial than the reorganisation of traffic control implemented in a smaller city; just oppositely than based on the expenses. Nevertheless, developments requiring smaller investments must be given increased priority as they can be carried out faster and in greater numbers setting a good example.

The future cannot be disregarded when planning urban transport. Besides preventing and mitigating climate change, for the sake of precaution, preparations have to be made for expected changes, which must include the consequences of climate change as well due to their impact on transport systems. The timely implementation of measures serving the adaptation to changed climatic conditions decreases the prospect of emerging transport chaos in the future.

5.1. MITIGATION POSSIBILITIES IN URBAN TRANSPORT

Greenhouse gas emissions can considerably be decreased by way of the climate-friendly transformation of urban transport, which contributes to the mitigation of climate change. This can be achieved by setting and simultaneously fulfilling three objectives. Firstly, occurring **travel demands** have to be reduced. Secondly, more **efficient and sustainable ways of meeting** these demands have to be found e.g. by giving preference to electric and other environmentally sound modes. Thirdly, the **energy efficiency of transportation** means has to be improved, thus diminishing the quantity of greenhouse gases emitted by vehicles running on fossil fuels. No significant breakthrough in decreasing the emission of greenhouse gases can be expected from performing just one of these objectives. To some extent, these efforts represent theoretical steps building on user awareness as well as strengthening it, and keeping the sustainability of mobility in mind; while they are also practical tasks in the significant restructuring of mobility.

5.1.1. Reducing demands in urban transport

The most efficient way of reducing demands in urban transport is developing a settlement structure where the mitigation of transport demands is seen as a priority in forming the utilisation of space by the different urban functions. Due to its significance, the handbook discusses climate-friendly settlement structure in a separate Chapter 4.

5.1.2. Spreading of more sustainable modes of transport

Even if a settlement structure is achieved that entails the least possible demand for motorised transport, the persistence of considerable urban traffic has to be reckoned with in European cities. The following section includes proposals for organising this remaining traffic in a climate-friendly manner, i.e. in a way that results in low greenhouse gas emission.

Development of the public transport network

The basis of a sustainable and climate-friendly urban transport system is a public transport network of excellent quality, easy to access, ensuring a quick reach of destinations and offering an attractive alternative to people who otherwise would travel individually in passenger cars. As a consequence of the size of cities, their inhabitants certainly need motorised means of transport. The partial substitutions of motorised individual transport can only be achieved by making public means attractive and developing it in a way that it can satisfy a wide scale of demands. However, it has to be emphasised that making public transport attractive is only one of the segments of establishing sustainable transport. Following appropriate preparatory work, mild, coercive and restrictive measures encouraging the use of public transport are, indeed, necessary, such as for example, banning traffic from certain areas, introducing some way of charging for usage, or limiting and transforming parking possibilities, and in general, by pricing and usage limitation which take into account the caused externalities.

In the European Union the average utilisation rates of both the individual and the public transport is 25%. However, while maximum 8 people can travel in a single passenger car at a time, the means of public transport can carry lot more passengers, so their per capita greenhouse gas emission is much lower, and in certain subsectors of the public transport we can speak of zero emission. During the rush hours, the difference in energy efficiency of individual and public transport may even grow to more than tenfold. (UITP, 2006)

Considering all the aforesaid, it is particularly disquieting that within urban transport, the share of public transport is continuously declining almost in all the cities of Europe. Currently, taking the number of trips by person as a basis, the proportion of public transport is near 30% in the cities of the European Union. However, there are significant differences across the continent: the highest values (over 50%) can be observed in the cities of Eastern and Central Europe but the proportion has been decreasing here, too. In certain European cities, some increase in the share of trips carried out via public transport has been achieved at the same time. (UITP, 2003)

The probability of using public transport depends on a number of factors. The usage of public transport in the urban and agglomeration space is ensured if the following conditions exist:

- a favourable network cover;
- an integrated tariff system, tariff community – interoperability between the individual modes and service providers;
- favourable pricing;
- efficient alternatives to reach destinations (speed, time, preference);
- high travel comfort;
- reliability, regularity according to schedule, safety;
- appropriate frequency and continuous access 24/24h; and
- availability and functional diversity of possibilities for changing modes.

Besides, the usage of public transport is influenced by a number of subjective factors:

- strength or weakness of the passenger car as a status symbol;
- individual assessment of public opinion on public transport;
- generalisation from own experience;
- the existence and efficiency of campaigns reaching the individuals; and
- the degree of environmental awareness.

It is a primary condition for a well-operating public transport network that its individual means can be **combined well with each other**. In the course of planning transportation links, one should pay attention not only to the demands of public transport in a narrow sense: in order to achieve the optimal effect, one has to open also in the direction of certain ’alternative’ and environment-friendly (e.g. cycling) and motorised individual forms of transport. This way it has to be made possible that even those who set off for the city by car cover the shortest possible distance by this means. Therefore, in the vicinity of the stops and stations of fixed track transport in the agglomeration settlements and outer city quarters, large car parks (P+R) and bicycle storage facilities (B+R) have to be constructed, and the transport of bicycles has to be allowed on some of the public means of transport, especially those covering longer distances. It is important to improve the accessibility of universities via public transportation and bicycle routes because of their significant, yet mostly only passenger traffic. It is imperative, however, that public and environment friendly transport services offer an alternative for passengers for the entire travel chain as much as possible.

The various transportation modes serve the interests of the city dwellers the best if they are not competing with but complementing each other.

The competitiveness of public transport is greatly dependant on its **affordability**. According to a survey carried out in Germany, in an average German city (Freiburg) the share of passenger cars in the local transport is 42%, and the shares of public transport, pedestrians and cyclers are near 20% each. However, out of the expenditures of the city allotted for transport, nearly 60% is used for supporting individual car transport. This distribution does not help public transport gain more ground. If we really want to change the status quo, public transport has to be given priority in finances. The support scheme of the subsidies provided by the EU is already sufficiently broad for the implementation and development of efficient urban and suburban fixed track transport systems from community resources. However, it is the cities’ and regions’ responsibility and duty to prioritise among developments, as well as to recognise the most urgent problems and define their treatment.

From the perspectives of both affordability and the integrative approach, the attractiveness of public transport can be increased by a **uniform season ticket** and ticket system covering the entire city and even the agglomeration settlements, i.e. by a tariff community, which is based on the logic of transport associations and means one of its branches. Furthermore, by defining different tariff zones for P+R systems with generally low prices and free-of-charge use in the outer areas and in the agglomeration, mode-switching can be encouraged. In case of smaller cities, making the entire public transport network free is also possible, taking, however, into account that the European experiences are very diverse in this respect and, socially, broadening the spectrum of users not only solves but also creates problems.

Although the construction and operation of public transport systems are financially costly, taking also its social and environmental benefits into account, in economic terms, efficient investments can become remunerative. Contrarily to the ’hard’, isolated infrastructure constructions (e.g. non-interoperable metro/underground), efforts have to be made to establish **interoperable fixed track systems** (utilisation of Light Rail Transit - LRT, tram and railway lines in urban transport). These solutions can ensure the integrability of the existing and new network elements and the minimisation of the number of transfers, which shorten travel times and increase the attractiveness of public transportation as a worthy competitor of individual transport.

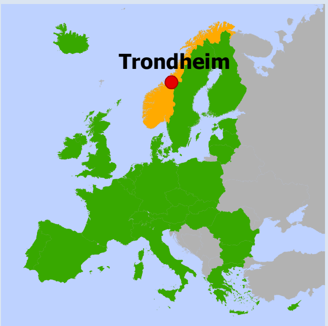
Trams are one of the most flexible means of transport, and are currently having their renaissance in Europe. They can be operated even in pedestrian streets or limited traffic areas where they run nearly at the speed of a pedestrian (and they contribute to the good atmosphere of public spaces), while in the outer areas, they can play the role and reach the speeds of underground and local railways. In addition, the distances between stops can optionally be varied in each section, so they can be better aligned with local transport demands. The competitiveness of trams is improved by the establishment of a system which enables the tram to switch the traffic light automatically in junctions after checking in so that it is given way and can, consequently, run continuously. All these advantages can be reached approximately for one-twentieth of the construction costs of a metro system (Michael Cramer, 2006).

An ideal means of transport in the internal city quarters is the **trolleybus** widely used in Eastern and Central Europe. Similarly to trams, it does not cause direct emission of pollutants; at the same time, the construction of the necessary overhead contact line network and its potential relocation is cheaper and can be implemented more simply than laying tram rails. However, its disadvantage is that it ’contributes’ to the potentially forming urban obstacles and traffic jams just as buses do because contrarily to trams, a trolleybus does not run along a protected, closed track. On the other hand, similarly to trams (but differently from buses), in case of an obstruction to traffic or an accident, trolleybuses cannot ’escape’ to any bypass road either, due to their fixed system of overhead contact lines, which also, has quite a significant effect of deteriorating the cityscape.

However, it is important to mention that the formerly existing sharp borderlines between the individual transport subsectors are slowly disappearing. In case of the modern vehicles, the difference between buses and trolleybuses has significant decreased; the automotive trolleybuses (battery, supercondenser, diesel engine, etc.), and the nearly zero-emission buses or those supplied with EUR5 engines are already almost compatible with each other. In several cities there are vehicles (e.g. Translohr) that constitute a transition between trolleybuses and trams.

Bus Rapid Transit (BRT) introduced in a number of cities in Asia and South America, e.g. in Bogota, is also an interesting possibility but it is not the model for European cities. This system is similar to the tram lines to the extent that the traffic is performed along a track separated from the other segments of transport, i.e. it operates in a bus lane system interweaving the city. In this case, the cost of laying the tram rails can be spared. Its installation can be recommended primarily in places where neither a tram or metro/underground system nor any adequate financial resources are available yet, but in the cities of the Third World growing by leaps and bounds a short-term and efficient solution is needed.

In summary, the milestones of an efficient public transport are as follows:
– good combination possibilities taking the regional and urban development features and intentions into account;
– uniform ticket and season ticket system and tariff community as part of the transport association model;
– competitive ticket prices;
– easy availability;
– some kind of a public means of transport has to be available within 500 metres;
– predictable and regular frequency of services, reliable schedules;
– appropriate comfort level, including cleanliness on the vehicles and at the stations and optimal utilisation (not very crowded services);
– establishment of bus lanes;
– automatically giving way to the vehicles of public transport but always to fixed track vehicles at junctions (by the help of using Intelligent Transport Systems);
– growing usage of fixed track systems within the cities; ensuring interoperability.



Trondheim: promoting public and individual non-motorised transport

Trondheim is the third largest city of Norway with approx. 160,000 inhabitants.

Since the 1990s the city of Trondheim has been making efforts to take actions for limiting the emission of greenhouse gases, but the number of cars has continuously grown. Therefore, in the interest of achieving the objective set, it has elaborated a Green Transport Package whose main goal is that by 2018 the city reduces its CO_2 emission by 20% by making both public and non-motorised transport gain ground.

In order to achieve this objective, in 2008 separate bus lanes were constructed throughout the city to increase the efficiency and speed of urban public transport, in which lanes the buses can run at high speed and without any obstacle. At the same time, the allowed speed of cars has been limited. Also, the action of the city management, namely concentrating the workplaces in areas easily approachable by public transport, has contributed to increasing the utilisation of public transport. They relocated 1,000 existing workplaces to a designated area and, simultaneously, they specified that min. 60% of the new workplaces had to be established in this area.

After the relocations, Trondheim launched a campaign supporting bicycle and pedestrian traffic. The aim of the campaign is to make employees living in the city cycle and walk more and more. The number of so covered kilometres are measured and, based on their performances, the employees can be awarded. As a part of the project, it has been organised that the employees still using a car take more of their colleagues to their workplace by sharing their cars, thus reducing further the emission of greenhouse gases. Additionally, the management of the city uses more and more electric cars; today Trondheim, owning 23 such cars, has the largest electric car fleet in Norway.

As a result of these actions, the number of trips in passenger cars has decreased by 150,000 annually, the proportion of employees going to work by car has diminished from 50% to 16% and car usage measured at rush hours has dropped by 20%.

It is thought-provoking that, according to the survey made on the popularity of the project, the action was not popular in the beginning (55% of the respondents had a negative and only 45% of them had a positive opinion about the innovation) the ratio was reversed in a year (63% had a positive and only 37 % had a negative opinion).

Contact:
Hans-Einar Lundli
Telephone: 72 54 25 84
Address: Erling Skakkes gate 14, 7013 Trondheim
Web: www.trondheim.com/engelsk

The Swiss Association of Public Transport

In order to increase efficiency and the number of passengers of the railways in Switzerland, a complex multistep public transport structure was introduced in 1982 based on an integrated, symmetrical regular-interval timetable (*Integrierter Taktfahrplan* – ITF). The system is based not only on periodic train departures but harmonizes the whole of the public transport network. The competitiveness of the community transport could be significantly increased by reducing and harmonizing the transfer times between trains and by establishing two-directional symmetry of traffic in the timetables As the maintenance costs of the railway network are considerably higher compared to the operational costs of the lines, increasing the supply of service proved to be reasonable. Thus, with the introduction of ITF, a mere 4% increase in costs resulted in a 21% growth in the services offered. In the 1980s, several private railway companies as well as urban transport and bus enterprises operating in Switzerland joined this system, which has been continuously developed to satisfy the needs of the passengers as much as possible. In 2004 already 55% more passengers travelled by train than prior to the launch of ITF, clearly justifying its introduction.

An inevitable part of this system was the harmonization of urban and long-distance transportation. Not only are the timetables adjusted to each other: the main transport service providers were also integrated into a transport federation, a tariff community. The distribution of revenues is a key issue here. The revenue from tickets purchased within the uniform tariff community goes into a single account, which is then allocated among the service providers according to the distribution of demand. The distribution is based on the passenger-kilometres and the number of trips, taking into consideration, of course, the characteristics of the different modes of transport. Such distribution of revenue, i.e. in proportion with actual demand, incites the service providers to improve service quality and to increase demand. The mutual interest of the different service providers and the transparent financial arrangements ensure the successful operation of the system, which is proven by the results achieved so far and the large number of participants in the transport association.

The revenue distribution system was presented as a good example within the framework of the SPUTNIC project. SPUTNIC (Strategies for Public Transport in Cities) was supported within the 6th Frame Programme of the EU. Its aim was to make public transport more attractive and efficient by preparing the interested parties for expected challenges, giving them an up-to-date overview of relevant professional knowledge and research, as well as providing them with concrete guidelines and practical tools.

Contact:
Web: www.tnw.ch/
SPUTNIC partner
Martin Ruesch, Rapp Trans AG
Telephone: +41 43 268 60 43
E-mail: martin.ruesch@rapp.ch

Traffic calming – traffic evaporation

In line with earlier traffic planning theories, the extension of the road network was most often seen as the proper means to improve the traffic situation along congested road sections with regular traffic jams. However, sustainable, climate-friendly cities do not consider this to be a solution to the problem: instead, they strive to reduce traffic in the problematic areas – or optimally, in the whole city – by focussing on the rearrangement and reduction of mobility needs. This means that these cities do not fulfil the space demand of passenger cars but intend to reduce it. This can be achieved by **consciously regulating the terms of passenger car traffic** – by employing supportive and restrictive instruments. According to observations, the gradually declining traffic circumstances may discourage city dwellers from using passenger cars and can result in an increased use of bicycles and public transport. Nevertheless, this can be a successful method only if implemented successfully within an integrated approach. Real and lasting success can be achieved only by improving alternative transport modes (public transport, the conditions of bicycle and pedestrian traffic) simultaneously with and complementing restrictions on car traffic. This means that first alternative means have to be made available providing adequate proper options for mode shifts to those who want to use public transport services.

Meanwhile, provided certain conditions are met, some part of passenger car traffic may even ‘disappear’. According to a case study (Goodvin et. al 1998) evaluating more than 100 cities, in almost 100% of the cases, 14% of the original traffic can wear off. This means that greenhouse gas emission by cities is reduced by the exhaust gases produced by this amount of cars. Immediately after the introduction of traffic restrictions temporary traffic chaos may emerge for a couple of weeks, however, this situation only lasts until the drivers learn which ways are better to go amidst the new traffic conditions. Within a year after the restrictions were imposed, the new habits are formed, people using cars may (partly) start switching to other transportation means, and may reassess the practicality of driving into the traffic-calmed areas. The long-term effect of traffic calming strongly depends on the complementary measures. In some of the studied cases, although lower intensities of traffic become more and more adopted, it may happen that cars slowly reappear on the roads. The precondition for an actual decrease in traffic is that road closures and the inhibition of passenger car traffic is realised in practice. In case there are significant unused capacities in a different period of time in the given part of the town or free capacities offered by alternative routes, the traffic is only transferred to these time periods or routes, and will not be reduced altogether.

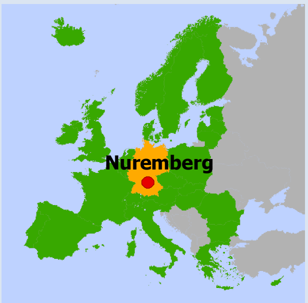
One of the simplest methods from among the wide range of traffic calming instruments is the partial or total **closure of certain roads, squares** – in area or time – from traffic. Pedestrian areas or areas of mixed use may function as local public spaces, and can assist the increase of the city's tourism potential, which in turn, invigorates trade in the concerned areas of cities, substantially contributing to the revitalization of these - mainly downtown - areas and help stop their decline. However, logistics in these city parts needs to be adequately handled, the storage of the local residents' vehicles has to be solved by means of parking houses, garages, and client parking has to be effectively regulated in surface parking lots. A more extreme, but effectual way of regulating parking is the reduction of the number of parking lots, which allows alternative uses of these areas (bicycle tracks, sidewalks, green area, etc.).

The introduction of **entrance fees** may also lead to a decrease in traffic in certain – mainly downtown – areas (generally called as '**congestion charge**'). This instrument is applied in several cities of the world with different emphases: while e.g. in Oslo the aim was to generate income, in London and in Stockholm this measure was introduced to reduce congestion, and in Milan the emphasis was on the cutting exhaust emissions. The smaller towns of Durham (England), Znojmo (Czech Republic), Riga (Latvia) and Valletta (Malta) also use congestion pricing to reduce traffic jams, particularly during the peak tourism season. Based on the experiences from functioning charging systems, following their introduction, people partly adapted by choosing other times for travel, and partly by modifying their routes, while others switched over to public transport or bicycle; also, certain part of earlier traffic disappeared, by which total traffic was reduced. At the same time, the received income can be utilised for the enhancement of the more sustainable means of transport. However, this measure for reducing congestion in dense city areas is a controversial one. The most important limiting factor of implementing it is that without sufficient parking space and an effective public transport system, the expected benefits cannot be reached. Also, the creation of parking lots can concentrate car traffic and increase pollution in their neighbourhoods. Besides, even in a perfect system, the situation arises that those who live outside the urban area have to pay this tax, while the external benefit is granted to those who live within the given area.

Setting **parking charges** is also a practical way to achieve decrease in traffic. According to observations, the introduction of parking fees reduces the volume of passenger car traffic by an average of 10%. However, parking fees and regulations cannot be efficient unless they are determined within a comprehensive, integrated urban development plan designed for the whole city, in accordance with a parking management plan. Information systems reporting on the currently available free parking capacities must form an integral part of the parking system of cities. With their help, parking space seeking traffic emerging in the area of downtowns (which can be as much as 20% of the total traffic) can be significantly reduced. Parking in agglomeration or suburban areas facilitating transport mode change, downtown residential parking and client parking have to be clearly distinguished within the parking system and the time-frames and logic of defining their fees have to be differentiated accordingly.

A further possibility is to consciously locate traffic calming installations that **reduce the speed of traffic**, and which urge drivers to rather avoid the particular road. Locating the sidewalks, bicycle roads and parking lanes on the same level may also result in the same effect. However, when planning these traffic calming measures, the proper evaluation of traffic needs and the capacity of the surrounding road network is extremely important. If there is no other alternative route in the neighbourhood, and it is not possible to reduce traffic needs, it may happen that the traffic along a road 'packed with obstacles' will not be reduced but progress will become slower, traffic jams will occur more often, and as a consequence, local air pollution levels may significantly rise.

Traffic calming may not only cover several roads, squares but also be extended to entire residential areas. By way of careful planning, involving local actors, some spaces within the city may be created where inhabitants do not own cars, and where only vehicles of emergency services are allowed to drive into.



Nuremberg, traffic calming

Nuremberg is situated in the south-western part of Germany, in Bayern, having approximately 500,000 inhabitants.

Solving the problems coming from increasing traffic was becoming more and more urgent during the 1970s due to growing air pollution, noise, the slower and slower traffic, and progressively growing congestion. The leadership of the city intended to reduce the traffic load; therefore, for the first time they started to clear out traffic from the city centre. This was implemented in several steps, till finally, by 1989, certain parts of the downtown had been transformed into pedestrian zones. However, public transport services were continued here as well.

Besides blocking motorized traffic from certain areas, buildings were renovated, street equipment was developed, and pieces of art were installed so that the atmosphere of the city became more attractive for both the inhabitants and the tourists.

The interventions related to the roads have had a significant effect: downtown traffic was actually reduced by 21,176 vehicles (double what had been planned), and by 1993 traffic was reduced by 36,044. This decrease was not transferred to the external rings, where measurements also showed a decline in traffic (between 1989 and 2000, by 10,000 vehicles). So closures have not resulted in bigger traffic jams but on the contrary, in reduced congestion, which have led to an improvement in air quality.

Traffic reduction on Rathausplatz represents the success of the measures: between 1988 and 1993 traffic was cut back to zero from 24,584 cars daily. Despite this, traffic on the surrounding roads did not increase but also dropped from 67,284 to 55,824 cars during the examined period of 5 years.

Contact:
Nuremberg city
Telephone: +49 (0) 911 / 231- 32 22, - 55 55
Fax: +49 (0) 911 / 231- 51 90

Bicycle road network and connected developments

Riding a bicycle is an integrated part of urban transport, which is dealt with due consideration by the managements of climate-friendly cities. Increasing the proportion of the bicycle usage can result in a reduced use of passenger cars, and as a consequence, in lower levels of greenhouse gas emissions. Riding a bicycle has several positive effects: due to its positive impact on urban air quality and the growing preference of physical exercise, it is advantageous to the inhabitants' health; it can help reduce the number of traffic accidents in the city; and because bicycles are more economical with space than cars, certain infrastructures (mainly parking places) become redundant and their surface may partially be converted to green areas. Altogether, cycling is also cheaper than traditional individual motorized transportation.

The chances are higher for the large-scale adoption of the bicycle as a means of transport in those cities especially which lie on flat land; although, based on experience, the climate has less significance, contrary to preliminary estimations. Interestingly, riding a bicycle has the highest popularity in those cities where the weather is typically cold, wet and windy. Several **preconditions are needed for making cycling popular**; these have to be indicated in the integrated urban development plan.

- Riding a bicycle may be effective and widely accepted where the riders and the other participants of traffic mutually acknowledge and respect each other, no matter what kind of infrastructure is available.
- It is necessary to have a continuous bicycle network. This means not exclusively or primarily the existence of separate bicycle roads; there is a large variety of other solutions ranging from traffic-

calmed roads, through widened outer lanes, bicycle tracks, and open bicycle lanes to separate bicycle roads. When scheduling their construction, it is advisable to make sure that connections are already available to the newly constructed sections or that there are safe connecting roads between each section. The bicycle network has to be linked to the public transport network. Proper bicycle storage facilities have to be created at the stations; furthermore, the transportation of bicycles has to be made possible on the means of long-distance public transport (mainly suburban trains).

– Networks that may be used by bicycles have to be adjusted according to the main transport directions. Therefore, the construction of bicycle networks demands serious planning preparations, taking into consideration already existing innovations, as well as the application of transport-technological solutions that are favourable for the cyclists.
– Bicycle tracks and roads must be maintained.
– The identification and construction of roads where cyclists may ride has to be accompanied by efforts to popularize the bicycle as a means of transport, as well as with the provision of up-to-date information about the bicycle network.
– Bike racks must be set up in all parts of the city.
– Following a variety of popular practices in Europe, bicycle rental systems have to be set up to cover ever increasing areas.
– Both physically as well as in terms of air quality, safe conditions for cycling have to be ensured as a priority during both planning and operation of the infrastructure.

In Western Europe it is a common practice to establish **bicycle rental systems** with parking places and free-of-choice pick-up and drop-off possibilities. Their construction is very important, as they increase the proportion of cyclists in the city. However, it is only viable if there are already existing well-developed, cyclist-friendly networks, or at least, those are constructed simultaneously. Besides cash and credit card payment options, it is advisable to introduce other payment methods (through the mobile phone or the city card for tourists) when renting a bike. It must also be mentioned that – mostly in cities with greater populations – cycling serves more as an alternative to pedestrian traffic and public transport than having any significant effect on the volume of motorised traffic. However, for people coming from the external areas of towns – mainly the younger generation – and for tourists, using the bicycle may be an attractive possibility in case bicycle renting stations connect well to the public transportation routes. Serious political commitment is necessary for the construction and operation of a bicycle renting network. Its costs are covered by the sale of promotional surfaces, or in other places, by the revenues from parking fees.

Lyon, bicycle sharing network

Lyon lies in France, 460 km from Paris in the South-Eastern part of France, with a population near 470,000 inhabitants.

In order to reduce passenger car traffic in the city, and keeping an eye on the health of residents, the city management of Lyon cooperating with the JCDecaux marketing company launched the Vélo'v project in May 2005, and at several locations in the city, bicycles could be rented. Renting a bicycle takes place as follows: there are cards in the renting stations, and bicycles may be rented for a 24-hour period. The first 30 minutes are free, from 30 to 90 minutes, the use costs 1 euro, and over 90 minutes, each additional hour costs another 2 EUR. In case of a long-term rent, one has to register in the system and pay a registration fee.

After use, bicycles do not have to be returned to the same spot where they were rented, they can be left at any Vélo'v station. Currently there are 340 bicycle renting stations in Lyon, but according to plans, in the future there will be stations located in every 300 metres. In year 2006, these bicycles were rented a total of 22,000 times, which actually meant a 44% increase compared to 2005. Calculating from the number and location of rents, the total length of the routes covered on bikes was altogether 6,400,000 km.

Contact:
Web: www.velov.grandlyon.com/Contact.16+M52087573ab0.0.html

Supporting pedestrian traffic

When planning urban transport, pedestrian needs have to be also taken into account. Like cycling, walking is also an environment-, climate- and health-friendly mode of transport. Significant increase in its proportion can be expected mainly in areas blocked from passenger car traffic as well as in traffic-calmed areas. However, besides these compelling factors, people have to be inspired to walk short distances. For this, however, proper circumstances have to be established. Broad, shadowy **sidewalks** surrounded by green areas and suitably equipped with benches can be attractive for short walks. The **minimization of the number of stairs** to be climbed is a basic expectation on behalf of the handicapped, the elderly and residents with small children, as well as the construction of ramps and a complex barrier-free system. It is important that the otherwise wide-spread **pedestrian streets** are connected to each other and give access also to the green areas of the city (especially taking into consideration families with small children).

The attractiveness of pedestrian transport can be further increased by installing **traffic lights** at intersections in a pedestrian-friendly way. This means that on the roads having heavy pedestrian traffic across them, traffic lights have to be programmed so that they turn green for pedestrian traffic at least once every minute even if this is less beneficial to other, motorized traffic. Connected to this, in the inner city areas, pedestrian crossings can be also elevated, which renders pedestrian crossing more convenient and forces cars to slow down. It has to be evaluated in each case what has a bigger priority at the given intersection: facilitating an undisturbed flow of vehicle traffic, or the preference of walk. Where the emphasis is put on is a political decision; conflicts arising from the changes and rearrangement of priorities can be resolved in the long run.

However, a single important circumstance fundamentally influences the increase of pedestrian traffic. An **integrated urban texture** must be created where distances are small because the workplaces, sites of shopping, entertainment as well as residential areas lie close to each other. Additionally, the popularization of pedestrian transport is necessary. A good example for this is the 'institutionalized' popularisation of walking among children through the 'pedibus'.

Eisenstadt, PEDIBUS

Eisenstadt is the capital of the easternmost province of Austria, Burgenland, with a population of 14,000 inhabitants.

The idea of the PEDIBUS project was conceived in the minds of the local school leaders when, as a result of a thorough school renovation and reorganization project, the traffic around the school significantly increased, with frequent traffic jams around the rush hours, which led to a significant increase in polluting emissions, and significant risks to the children. When launching the project, the organisers' main target was a 60% reduction of traffic around the school.

The PEDIBUS means that children from the school walk on a selected road under the supervision of an adult, on foot to and from school every morning and afternoon. One may join the 'school march' in the indicated stops, where the adult supervisors replace one another as well. The project was launched in the school year 2007/2008, along 3 routes. At the end of the school year, the project was considered successful, therefore, the participants decided to continue it. The targeted 60% decrease of traffic was achieved as well. The other outcome of the project was the positive effect on the community and the social attitude.

The advantage of the PEDIBUS is that by using a minimum budget, it can be realized with the assistance of the parents. The only possible cost may be the fee of the escorts, however, in Eisenstadt this was performed as volunteer work by the participants.

Contact:
Maximilian Schulyok,
E-mail: kommunikation@eisenstadt.at
Telephone: +43-268 270 5712

Propagation of alternative public transport solutions (car-sharing, full-car system, organized hitch-hike)

The largest disadvantage of public transport is that it is not adjusted to the destination of the individual traveller, which means that one needs to walk much during the travels and the transfers and waiting take a considerable amount of extra time. A well-organized public transport network may however, significantly reduce these drawbacks, though it may not solve these problems absolutely. There are some public transport modes that are suitable to be adapted to the needs of individual travellers. Although their disadvantage is that they can carry only a fewer number of people, and therefore they are less effective than traditional public transport modes, compared to individual transportation, they are more efficient. Such modes introduced below may be appropriate ways to reduce passenger car traffic in a city, and thus, the emission of greenhouse gases. Nevertheless, it is true that this can be achieved only provided that certain conditions are met.

'**Car-sharing**' is a special form of borrowing a car. It provides a car for a short term (e.g. a few hours) for the participants; but depending on the type the vehicle, the car may be rented for days. The primary target of the system is to contribute to reducing the number and the use of the cars privately owned. The cars may be hired from and dropped off at any pre-indicated station if the system is a well-operating one. Nowadays, this kind of short-term car-rental service is taken on mainly by private enterprises, but several transportation companies keep significant fleets, like for instance, the German Railway Company (DB) in Germany, or the STIB, the local transportation company in Brussels. However, in order to reinforce the climate protection aspects, local governments can also operate such car parks since following the initial investments, the running expenses are relatively affordable. A cut in greenhouse gas emissions may be achieved most effectively if the car rental stations are located close to where long-distance train lines reach the city, and to the stations of suburban railways, tramways, and to bus terminals. This way the distance of travel covered by those arriving from the suburbs and the agglomeration settlements may be reduced. This can decrease traffic on the incoming roads in the outskirts of cities; however, significant reduction in traffic cannot be expected in the city centres. The latter can be achieved only if the cars for rent are powered by environment-friendly technologies (electric, hybrid). At the same time, a significant benefit from this system is the decrease in the number of cars parking in the downtown area, which in turn results in the increase of spaces available for other purposes.

Besides municipalities, employers may also establish similar systems, where company-owned cars collect the employees each morning and transport them home in the afternoon (carpooling). Of course this means certain inflexibility for the inhabitants, however with a proper incentive scheme both the enterprises and the employees can be persuaded to operate and use such systems. The cars serving such goals can be specially marked – depending on their loads – and be allowed to use bus lanes; and both the employers and the employees can be motivated financially with allowances or tax reductions. In order to operate this system, it is necessary also to provide cars for trips during the day in a rental system.

A complementary form of public transport may be – especially in sparsely populated agglomeration and suburban settlements – the creation of favourable conditions for **hitch-hiking**. The essence of this transport mode is that stops shall be designed and marked where passengers may be picked up. It is advisable to locate these stations next to the main roads and close to public transport stations. We cannot expect much from the resurrection of hitch-hiking since it requires a huge amount of trust on behalf of both parties. However, the creation and maintenance of the stops cost very little, it is reasonable to offer them to those few people who would like to use them. Besides, they may have an exceptional marketing potential!

Climate-friendly freight transport in the city

The methods introduced so far and aiming to reduce the traffic load on cities are, without exception, targeting the reduction of passenger transport. However, freight transport vehicles participate heavily in urban traffic, contributing much to the production of local air pollution. A wide-spread measure to regulate urban freight transport is the prohibition of large trucks from entering certain – mainly downtown – areas of cities. This decreases air pollution of those particular districts; however, this regulation does not have a decisive reducing effect on the volume of greenhouse gas emissions in the whole city and region.

However, city management can create the foundations of climate-friendly freight transportation that results in reduced emissions of greenhouse gases. The key to this may be the creation and operation of **consolidation centres**. These latter are such logistic bases which are located nearby the areas to provide for – mostly a certain part of the city, or an entire town, a shopping mall, a major construction site –, which areas are supplied from these bases mostly by means of smaller vehicles (M. Huschebek, J. Allen, 2005). Opinions vary on the advantages and disadvantages of urban logistic centres, however, there is agreement as to the fact that they are efficient from the point of view of environmental and climate protection. An assessment of the results from 17 sample projects indicates that after launching the system, the total distance covered by the trucks decreased on average by 35-40% in the related part of the city, the capacity utilisation levels of the vehicles increased by 15-100%, and as a consequence, NO_x and greenhouse gas emissions by trucks decreased by 25-60% (M. Bourne, M. Sweet, A. Woodburn, J. Allen, 2005).

Nevertheless, in order to for these transit stations in cities to be really effective, several conditions have to be ensured; otherwise these centres can easily cease to operate completely, as it has happened in some cities in Germany over the last decade. Therefore, the creation of urban consolidation centres requires well-grounded and comprehensive demand survey and planning. The establishment and operation of consolidation centres can generally fulfil expectations if they are operated in a clearly delineated city area with some special features (e.g. downtown area, car-free zone), where there are a lot of shops that do not belong to any commercial chain (and as a consequence, neither to any supply chain), and where traffic on the roads is high. The establishment of city consolidation centres in large construction and commercial areas, although it is less noticeable to residents, serves the reduction of greenhouse gas emissions in the city.

5.1.3. The reduction of specific emission of greenhouse gases by transport means

With the help of the methods introduced above, transport needs may be reduced only to a certain level. In order to decrease further the emission of greenhouse gases deriving from urban traffic, the reduction in the specific emission levels of vehicles is a precondition. With a Decree in 2009, the European Commission set the maximum greenhouse gas emission level to be applied to new passenger cars. According to the Decree, by 2020, compared to the values in 1990, emission levels have to be reduced by 30%, i.e. to an average of 95 g/km. However, city management should not be content with the reduction in greenhouse gas emissions coming from this measure, but has to support the targets of climate protection with the following instruments.

Increasing the proportion of low-emission vehicles in public transport

There are significant differences between the CO_2 emissions of vehicles. The following chart contains average figures for various types of passenger transport vehicles:[1]

Passenger transport vehicle	Grams CO_2 per seat km	Number of seats
Medium-category car	78	5
Urban diesel train	60	146
Metro/underground	46	555
Tramway	39	300
Light rail	38	265
Diesel bus	33	49

Table 1: The CO_2 emission of vehicles (Source: David A. et al., Oxford, 2003)

With respect to the data above, and with a consideration of climate protection, the proportion of suburban train, tramway, light rail and buses has to be increased within urban public transport. When purchasing vehicles, one has to take into consideration the costs arising during the entire life cycle of the given vehicle, due to which those energy-saving vehicles which first appear to be costly can turn out to be in fact, less expensive. In the following, from among these possibilities, we would like to introduce some solutions by which the emissions by light rail and buses can be decreased. Nonetheless, it has to be emphasized that each city and region will have to find the best solution being aware of their already existing systems and their inter-operability potentials.

Light rail may be considered as a climate-friendly and energy- efficient solution in urban transport, especially in suburban areas. In order to increase the energy efficiency of these, a survey was performed to find out which aspects influence their energy efficiency to the greatest extent. Based on the findings of the MALTESE project targeting the above aim, these features are the following: the number of intersections; the number of stations created within underground sections; the construction of the lighting and ventilation systems of the underground sections; train succession density; the distance of the garages from the metro line; the frequency of acceleration and braking; and the load of the rolling stock. Some of these aspects can be optimised by simple and feasible actions, but some require expensive technical solutions. In case of the latter, the responsibility of an environment-friendly local government is limited to the consideration of energy efficiency aspects when choosing the vehicles. However, implementing measures to raise energy efficiency by means of the organization of traffic is a task of city planning and operation. Below is a short summary of solutions serving the energy-efficiency of light rail, grouped according to the most critical aspects of energy consumption:

- The number of intersections:
  - Application of a traffic light system which gives priority to trains (ITS – Intelligent Transport System),
  - Constructing stations close to the intersections.
- The length of the underground sections, and the number of stations:
  - Replacing underground sections where possible by protected surface lanes,
  - Shared use of the underground tunnel by several light rail lines.
- Lighting of the underground stations:
  - Covering the wall of the stations in bright, reflective substances,
  - Possible minimization of lighting, use of energy-saving lamps and bulbs.
- Train density: the effectiveness and the enhanced role of light rail within the public transport system depend on the frequency in train succession. Its optimal level contributes to efficient utilisation. Rapid succession is required especially in the rush hours.

[1] The data were provided by the public transport companies of the United Kingdom to the authors of this book. The authors compared these with the data referring to the European cities, and they found significant differences, therefore the below data are general for the whole of the EU.

- Location of garage:
  - The garage has to be the closest possible to the lines.
  - Daytime the trains may stay out of the garage; they may as well park on a sidetrack.
  - The vehicles should be used for passenger transport also between the garage and the lines.
- Acceleration / braking: there are several technical solutions for the reduction of the energy use and loss occurring during acceleration and braking. When choosing the vehicles, it is advisable to pay attention also to this.
- Load of the rolling stock.
- The size of carriages has to match the size of traffic.
- In case of low traffic, shorter trains have to be used.

Dublin, light rail

Dublin, the capital of Ireland, has 1 million inhabitants including its agglomeration.

In order to reduce air pollution, two light railways were built in Dublin co-financed by the Regional Development Fund of the European Union with a sum of by 82.5 million EUR. The constructions were started in 1999, and the two lines were finished in 2004. The idea was successful: in the year 2008, 27 million passengers used this means of transport; furthermore, the project needed support for operation costs only in the first few months, afterwards it started to produce profit. Motivated by this success, Dublin is planning to establish further lines.

Contact:
E-mail: info@luas.ie
Telephone: 00-353 1 461 4910; Fax: 01 461 4992

Concerning solutions for **buses**, in the area of reducing CO_2 emission, a breakthrough can be expected from the spread of hybrid buses in the short run and in the long run, provided that renewable energy is used, the spread of fuel-cell buses. Both bus types can be acquired yet at a relatively high price, however, their operation does not cost more than that of traditional buses. The use of hybrid buses may result in a reduction of fuel consumption by 30%, which can significantly reduce greenhouse gas emissions (www.volvobuses.com). Before introducing hybrid buses into regular-service operation, it is advisable to try these buses during a test period on potential lines to investigate on which line hybrid buses can operate the most economically.

Ljubljana, hybrid taxis

Ljubljana, the capital of Slovenia, has approximately 280,000 inhabitants.

When expanding its fleet, Rumeni Taxi of Ljubljana aimed at giving preference to the most environmentally friendly option in their choice of technology. Therefore, the company purchased three environmentally friendly vehicles in 2004 and in 2005; Toyota Prius cars were chosen. The taxis were equipped with a P-Box as well to increase the efficiency of engine power by optimising fuel injection system.

Besides an internal combustion engine, a hybrid car runs also on another, less polluting type of energy source. As a consequence, they do not mean as high an environmental load as traditional vehicles. Also, they are more silent and thus they help decrease noise pollution.

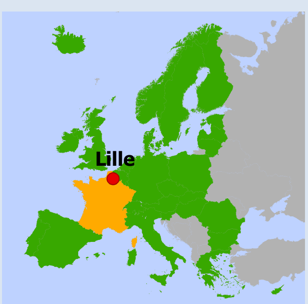
These measures met with great public approval. Certain environmental parameters and the extent of costs reduction are monitored also by the company. According to the first results, fuel consumption was decreased by an average of 1 litre/100 km with the use of the P-Box, which favourably influenced operational costs.

Contact:
E-mail: info@rumenitaxi.com
Web: www.rumenitaxi.com

From a climate protection point of view, fuel-cell buses represent the most perfect solution since they do not emit greenhouse gases at all. However, the production of hydrogen is a rather energy-demanding procedure, and consequently, considering their entire life-cycle, the level of greenhouse gas emissions by hydrogen-driven buses is high except for the case when hydrogen is produced with the use of renewable energy (e.g. wind or hydropower). Purchasing fuel-cell buses and putting them into operation can only be carried out in part of integrated urban planning since their operation requires the existence of the hydrogen-filling stations. Until the construction of these hydrogen fuelling stations, the use hybrid buses can provide a proper alternative.

The Fuel cell
In the fuel cell, the reaction between oxygen and hydrogen gained from the air produces water and electric energy. To prevent the formation of dangerous detonating gas, the hydrogen and the oxygen gases are channelled into the narrow routes of the cell plates laid upon one another, and these two gases are separated from each other with a platinum-covered proton exchange membrane. Hydrogen molecules split into positive hydrogen ions (protons) and electrons on the anode plate of the fuel cell, and the protons migrate through the membrane to the oxygen atoms on the cathode plate. Meanwhile, the electrons remaining on the anode plate cannot cross the membrane but they must travel along an external circuit to the cathode, creating an electric current. The electricity so produced is converted into a 250-380 Volt current, and feeds the electric engine driving the vehicle. The fuel cells, like common batteries, produce electricity with chemical reactions; the difference is, however, that while batteries have to be disposed of after they are ‘empty’, a fuel cell keeps on working as long as it is filled with fuel.

There is another promising solution: the introduction of **biogas-fuelled buses**. Biogas may be produced at waste disposal sites and sewage works.
buses can operate the most economically.



Lille, Buses driven by biogas

Lille lies in the North of France. It is the fourth largest agglomeration centre in the country having approximately 1,150,000 inhabitants. In the agglomeration of Lille, in the so-called Big Lille, approximately 4 million passengers are registered daily, and 90% of this traffic takes place in the city. Since, according to estimations, both the population of the city and the number of travels will increase continuously in the coming years, it has become reasonable to rethink traffic development of the relevant urban regions, as well as to investigate the applicability of the different means to meet the rising travel demand in a sustainable way.

The ‘Air and Rational Energy Consumption Act’ accepted in France in 1996 obliged the cities with over 100,000 inhabitants to outline an ‘Urban Traffic Plan’. The City Council of Lille drafted its Urban Traffic Plan in 1997, in which they aimed at supporting the use of energy resources resulting in lower pollution. The pilot project with biogas-fuelled buses was a part of this plan, too.

The goal was to run the urban and suburban buses on the biogas produced at the sewage treatment plant Marquette. Until 1990 15,000 m^3 biogas produced on this site was used to generate heat and energy for the treatment plant itself, while the remaining amount of 3,000 m^3 was burnt. From this, 1,200 m^3 was planned to be utilised as fuel. In 1995 a biogas cleaning system was installed on the site with a cleaning capacity of 100 m^3 biogas per hour and producing 50-55 m^3 bio-fuel per hour. This was enough to supply eight buses with bio-fuel by 1999.

In 2006, as a continuation of the project, a biogas power plant utilising organic waste was constructed in Sequedin (in the agglomeration area of Lille), with a bus depot next to it for 150 buses. This plant processes domestic and garden biowaste collected in special containers provided to every urban household. This biowaste (100,000 tons annually) is gathered weekly by refuse collecting vehicles that also run on biogas. Biogas is produced from biodegradable materials by fermentation technology, and then it is converted into biomethane fuel and transported to the nearby bus terminal. The buses tank once a day. They are more silent and emit less polluting material than traditional buses.

Contact:
E-mail: ybaesen@cudl-lille.fr

Climate-friendly driving style ('ecological driving')

In the past decades, the engineering characteristics and constructions of vehicles have significantly changed, and most of the drivers have failed to accommodate to these altered conditions. 'Eco-driving' is a driving style which results in lower fuel-consumption during the same travel period.

The five principles of climate-friendly driving are:
- Shift into higher gears as soon as possible!
- Keep a continuous speed!
- Act according to the traffic!
- Brake carefully!
- Check the tyre pressure!

Climate-friendly driving can result in significant fuel-saving, and according to the European Climate Change Program, 50 million tons of CO_2 emission may be saved yearly in Europe through its widespread application. In 2000, following a climate-friendly driving style course organised at Austrian bus company NIGGBUS, fuel consumption was reduced by 5%, and this value was increased to 7% by 2001 (www.ecodrive.org). Other advantages of climate-friendly driving are that it can help substantially reduce repair costs and the number of accidents as well.

One may learn to adopt the climate-friendly driving style in several ways, e.g. with the assistance of a simulator downloaded from the Internet. However, it is more effective to participate in a 1-2 day course organized for this purpose.

Cities can contribute most to the mitigation of climate change if the largest possible part of drivers learn and adapt ecological driving. Since it is a cheap and effective method, 'poorer' cities may also afford to organize courses themselves and can popularize this method. The management of the city can decide whether to make participation in the eco-driving courses obligatory for those who drive the vehicles owned by the city; furthermore, they may choose to award premiums to drivers who manage to reduce their fuel consumption.

Helsinki, route planner and CO_2 emission calculator

Helsinki, the capital of Finland, has approximately 570,000 inhabitants. Including its agglomeration, annual CO_2 emission is approximately 1,300 kg / person.

The Helsinki Region Traffic Authority (HSL), within the framework of the JULIA 2030 project, published a route-planning interface on its website which shows the CO_2 emission by certain means of transports. As a basis, the calculator takes the direct emissions by buses and cars, as well as the CO_2 released from producing the electricity used to operate other vehicles in transport. The emission of walking and riding a bicycle is zero; so for instance, the food consumed by people is not taken into consideration. The emission of other greenhouse gases is converted into their CO_2 emission equivalents.

It is a rather interesting feature of this tool that the energy consumed during travel by different means of transport or by walking is not only expressed in SI units (kJ) but also in chocolate-slice equivalent.

Carbon dioxide emissions and calculation methods

Keskuskatu 2, Helsinki - Kuusitie 5, Helsinki

Mode of travel	Distance	Emissions	Annual emissions per commuter trip *	Annual emission reduction **	Energy consumption of walking and cycling ***
Route suggestion 1	4,8 km	0,4 kg	77 kg	117 kg	167 kJ / 40 kcal = 1 pieces of chocolate
Route suggestion 2	4,7 km	0,3 kg	75 kg	119 kg	167 kJ / 40 kcal = 1 pieces of chocolate
Route suggestion 3	5,4 km	0,4 kg	90 kg	103 kg	147 kJ / 35 kcal = <1 pieces of chocolate
Cycling	5 km	0 kg	0 kg	194 kg	523 kJ / 125 kcal = 2.5 pieces of chocolate
Walking	5 km	0 kg	0 kg	194 kg	1047 kJ / 250 kcal = 5 pieces of chocolate
Car	5 km	0,9 kg	194 kg	0 kg	0 kJ / 0 kcal = 0 pieces of chocolate

* Emissions have been calculated for a round trip, 220 working days a year.
** Emission reduction has been calculated by comparing the emissions of suggested routes to emissions from an average car.
*** Walking included in travel by public transport has been taken into account in the personal energy consumption.

The development of the calculator was supported from the fund of the LIFE+ program of the European Union (LIFE07 ENC/FIN/000145). The budget of the JULIA 2030 project was 2,146,230 euro, out of which a sum of 1,073,115 EUR (50%) was co-financing by the EU.

Contact:
Project leader: Susanna Kankaanpää
Telephone: +358 915 611
Fax: +358 915 612 011
E-mail: susanna.kankaanpaa@hsy.fi

Traffic regulation

Besides the efforts aiming to spread the theory and practice of the climate-friendly driving, cities have several instruments to enforce its practical adaptation by the participants of transport. Speed limitations are among these solutions, as well as traffic regulation measures aiming to eliminate frequent stops and restarts, i.e. supporting the continuous flow of traffic. From the climate-protection perspective, the **reduction of speed** is recommendable mainly along the roads connecting settlements where a difference in speed can be reached which results in a noticeable reduction in emissions. According to surveys, the difference between the driving speeds of 120 km/h and 80 km/h reduces fuel consumption and consequently, the emission of greenhouse gases, by 30% on average. Reductions in emissions could be best served by revising the allowed highest speed on exit roads.

In urban traffic it is (much) more important to develop regulation that prevents (traffic) jams and frequent stops in the flow of traffic. These efforts have already meant a significant guiding principle in traffic regulation; in this chapter we only emphasize them further because a more continuous flow of traffic lowers the levels of greenhouse gas emission by a city. The creation and application of **Intelligent Transport Systems (ITS)** makes it generally easier to realize these aims. The basis of these systems is that the information related to transport and traffic is provided to the users in real time. With a wide-spread use of ITS – according to prevalent professional opinion – greenhouse gas emission deriving from traffic may be significantly cut, but no research is at disposal regarding the precise extent of this reduction (SE Consult, 2009). Optimal travel routes may be planned with the assistance of ITS based on the use of road sections without accidents, errors, traffic jams. The use of ITS makes it possible for traffic lights at intersections to change always according to the given traffic situation, reducing emission of the greenhouse gases (and other air pollutants) by way of decreasing the occurrence of unnecessary waiting and restarting.

5.2. ADAPTATION POSSIBILITIES IN URBAN TRANSPORT

According to widely accepted scientific theories, the transport sector can be itself exposed to significant damage caused by climate change besides substantially contributing to it. In order to prevent this damage, all actors of transport have to adapt to the changing climate. If the necessary measures in adaptation are implemented on time, the extremities will not affect transport companies unexpectedly and there will be less obstruction to urban traffic. Since the effects of climate change are very different across Europe, the necessary adaptation measures have to be also regionally specific.

Since they belong to different authorities, the problems of public transport and those relevant to the road network are discussed below in two separate sections.

5.2.1. Preparing the public transport network for climate change

Due to climate change, more frequently emerging extreme weather events may significantly depreciate the conditions of public transport, through which they may seriously affect the life in cities. In order to prevent this, local transport companies (their contractors and owners) have to be prepared for extreme weather situations. First those specific effects of climate change have to be identified that can be expected to occur more often in the particular city. The compilation of a matrix may be a good method where different modes of public transport are listed in the rows and various locally relevant climate change effects are indicated in the columns. The expected potential impacts of weather events on particular sub-sectors of public transport can be then listed in the cells of the matrix. From among the various weather effects, especially summer heat waves and floods have be taken into consideration because of their significant influence on transport.

Summer heat waves

Until recently, summer heat-waves have been typical primarily in Southern Europe; however, as a consequence of climate change, they will occur increasingly often also in Central and Western Europe. Furthermore, people living in these regions are not accustomed to extremely warm periods, and as a consequence, the ever frequent heat waves are expected to pose a serious threat to health in these parts of the continent. Heat waves represent a particularly significant burden to the participants of public transport. According to surveys, the temperature within the vehicles of surface transport can be as much as 4°C higher in the rush-hours than outside. In case of an extremely high outside temperature, the 4°C difference can raise the temperature to a life-threatening level inside the vehicles.

In the event of a heat wave, in order to protect passengers, the following measures have to be taken:

– Considering public health aspects, **air conditioning** systems have to be installed in public transport vehicles where it is needed and feasible. However, in climate-friendly cities, air conditioners may only be used if certain conditions are fulfilled since their use will significantly raise the fuel consumption of the vehicles, and consequently, their greenhouse gas emission levels. It is a basic rule that an air conditioner may only be used when it is really needed, and in the cooler hours of the day, cooling has to be done by ventilation (airing). Nevertheless, the additional emission caused by air conditioning equipments can be still a reasonable compromise since lacking them can be indirectly more harmful: passengers, looking for more comfort, may shift to using their own cars, which results in more serious air pollution.

- When a heat wave comes, **drinking water has to be provided** at the stations.
- The heat wave can alter the regular daily rhythm of traffic, so when assembling trains, it is advisable to flexibly react to the changed needs, and to facilitate an optimal utilisation of vehicles in order to reduce greenhouse gas emissions.
- For the vehicles participating in – especially, urban – public transport, it is important to have **large, opening windows** besides air conditioning, which enhance the ventilation and the cooling of the vehicles for temporary periods.

Although, underground transport vehicles are partly protected against outside temperatures, it may cause a problem that the large amount of heat produced in the tunnel is replaced at a slower rate than necessary due to the equalization of the underground and surface temperatures. In order to eliminate this problem, ventilation has to be increased in the summertime. For the purpose of cooling (and in winter, for heating) underground stations, the construction of geothermal heat pump systems have mostly excellent conditions.

Furthermore, heat waves do not only influence the state of the running vehicles but also that of the **infrastructure**. Railway or tramway tracks can be deformed by heat, which can necessitate speed limitation or temporary track closures. As a consequence, delays may occur, which also weaken the competitiveness of public transportation modes. Proper shading techniques can help reduce the extent and the occurrence of deformation caused by heat in the elements of the infrastructure; this practically means planting trees close to the tracks, planting grass between the tracks and using a material to build railway and tramway rails that are more resistant to changes in temperature (i.e. an alloy that has a lower thermal expansion coefficient). This measure – if it involves a bigger area – can have a favourable influence on the microclimate of the city. A further possibility is to cool the rails with sprinkler cars, although in dry weather, this can be feasible only in the busiest rush-hours.

Stations are important elements of public transport. When constructing them, changed climatic conditions have to be also taken into consideration. Flow-through ventilation, the structural design of the buildings and the formation of parks have to be carried out as described in Chapters 4 and 7 of this handbook referring to green areas and architecture.

Floods, storms

Floods mean an evident risk in case of towns located close to rivers. Underground tunnels in the lower lying areas and floodplains can be flooded; and the access to stations and platforms of surface transportation modes can become also obstructed. In settlements threatened by flood, it has to be investigated which are those sections of roads and tracks that are prone to flooding, and – if possible – it is advisable to raise the level of these. It is recommended to prepare an **emergency plan** in case certain sections of public transport have to be closed because of a flood. Alternative routes of public transport lines as well as substitute vehicles can be planned in advance. When designing this alternative public transport network and schedule, the changes in transport needs due to flooded sections have to be taken into consideration, too. These all may seem a small issue, but in case of emergency, these measures can help the situation so that the life of the city does not turn upside down even amidst extreme circumstances. Those parts of the infrastructure where there is a danger of wash-out, continuous attention has to be paid to, and the dams have to be strengthened. In the stations, the diversion of the redundant water has to be taken care of; Chapter 8 on water management provides some guidance concerning climate-friendly ways of doing that.

5.2.2. Development of the road and sidewalk networks

A significant part of urban traffic takes place by individual means, in cars using the road network of the city. Bus traffic, as a definitive component of public transport, also uses these roads. When a part of the urban road network suddenly becomes inoperative, this brings an extraordinary mess and upsets the life of the whole city, which situation can be further aggravated by the destruction of the sidewalks. Extreme weather can strongly influences these systems.

Summer heat-waves

During summer heat-waves, high temperatures can start melting the asphalt cover. This, on the one hand, disadvantageously influences traffic, and in extreme cases, may require the closure of certain road sections as well as the restriction of public transport using those; on the other hand, the scorching asphalt surfaces may further heat the already hot air of the cities.

The load bearing capability and wear resistance of asphalt depend on temperature. In high temperature range, above 30°C plastic deformation is more probable, this means that asphalt melts. The temperature of the asphalt surface much exceeds that of the air. Depending on the extent of radiation, on an average summer day, when the maximum temperature is 25°C, the temperature of asphalt may rise to 40°C. Temperatures above 50°C are not infrequent in the event of heat-waves. At such high temperatures, the rigidity of asphalt is over 20 times lower than it is at 10°C, and is still three times lower than at 30°C. However, the degree of deformation in the asphalt surface depends significantly on the composition of the asphalt mixture. Although it is true that the actual differentiation in rigidity between different compositions decreases along with temperature increase, there still remains a two-fold difference between the most and least rigid asphalt mixtures (L. Pethő, 2008). Of course, during winter time these differences would be favourable in just the opposite way. Naturally, choosing the size and the asphalt surface of the roads does not belong under the competence of city management but is the task of the professionals. However, the city can include these aspects as requirements in their calls for tenders in road planning and renovation; and what is more important, it is recommended for the city to cover the additional costs resulting from the use of better-quality asphalt.

In addition, it is advisable to make the surface of the road sections more resistant against heat where there is a higher point loading, e.g. in bus stops or at junctions. Shading the roads prevents the asphalt surface from heating up. As in many other cases, planting trees along the roads can offer a solution here, too.

Most of the sidewalks are typically made of asphalt as well. In places prone to experience heat-waves, the consideration of alternative pavement of sidewalks is recommended. According to surveys, walkways made of concrete get warm much slower in the summer than asphalt. In the hottest summer midday hours, when the temperature of asphalt may rise to 50°C, concrete heats up only to 25°C. A further advantage of concrete is its lower thermal sensitivity, meaning that it resists heat without any damage (www.terko.com). For sidewalks, too, shading, possibly by planting trees has a great significance.

Floods, storms

As a consequence of floods and sudden storms, part of the road and sidewalk network may be covered by water for a longer period, which may result in the closure of certain road sections in an extreme situation. Unlike in the case of floods, where it may be predicted which sections will be more affected, road sections potentially endangered by storms are more difficult to identify. In cities where storms can be expected to become more frequent, furthermore, where there is a higher likelihood of rainfall onto a cold surface in winter it is absolutely necessary to apply water permeable surfaces. Thus a puddle-free surface may be created with several climate-friendly characteristics. On the one hand, the chance of dangerous frost is reduced in the winter, on the other hand, this permeable surface does not close the groundwater system and the flora and fauna of the soil hermetically from surface precipitation.

From among the different building materials of sidewalks, bricks, loosely laid stones, concrete pavement blocks with enlarged joints, and granular road cover without binding material have favourable water-permeability characteristics. Considering the purpose of sidewalks, it is not a disadvantage that the load bearing capacity of these surfaces falls behind the commonly used asphalt.

BRIEF RECOMMENDATIONS

- Construction of climate-friendly, sustainable urban transport by means of reducing motorized transport needs.
- Preparation of an urban mobility plan.
- Reduction of emerging travel needs, and serving them more effectively and sustainably.
- Enhancement of the energy efficiency of the means of transport (e.g. raising the proportion of low-emission vehicles), promoting environment-friendly modes.
- Stimulating the use of alternative, environment-friendly (e.g. bicycle) means of transport instead of motorized individual transport modes.
- Development of the public transport system (of perfect quality, easily accessible, providing quick transport, and has regular frequency), making it attractive and creating a wide spectrum of needs, and widening its use in the city.
- Establishing large P+R parking lots and bicycle storage places (B+R), close to the stations and terminals of the railway lines in the agglomeration and suburban areas at low and zone-specific prices.
- Instead of constructing hard, isolated infrastructure (e.g. non-interoperable metro /underground), focussing on inter-operable rail transport (light rail, tramway, use of railway in urban transport).
- Introduction of traffic reducing measures.
- Forming traffic regulation which results in lower emission levels.
- Establishment and use of Intelligent Transport Systems.
- Creating and operating urban consolidation centres in order to make urban freight transport more climate-friendly.
- Preparation of the public transport network for extreme weather events (heat waves, floods, and storms).

6. LOW CARBON ENERGY MANAGEMENT OF THE SETTLEMENT

Reducing greenhouse gas emissions, improving energy efficiency and increasing the role of renewable energy play a significant role in the energy policy of the European Union. The target is to decrease total energy consumption by 20% by 2020, and to further increase the proportion of the renewable energy in the final energy consumption of the EU to 20%. In order to reach these targets and reduce greenhouse gas emission to different extents in different member states, increasing the use of renewable energy and improving energy efficiency are also crucial tasks in settlement level energy management.

Being part of the national network settlement energy management is constituted by those individual and other energy systems and subsystems whose regulation and physical variation can be influenced at the settlement level. Accordingly this chapter introduces possibilities, ideas and concrete examples for the amelioration, conversion and regulation of settlement level energy production and supply systems. Energy effiency refurbishment of public buildings, the improvement of energy efficiency of district heating, public lighting and other public utility systems belong to this topic as well. Individual applications (e.g. energy efficiency development of the residential buildings) and suggestions for the use of certain renewable energy sources in transportation are introduced in Chapter 7 on architecture solutions and Chapter 5 on urban transport.

Settlement level energy management is mainly connected to the mitigation of climate change, since improving energy efficiency and increasing the share of renewable energy sources in the local energy mix result in the decrease of greenhouse gas emissions. Options regarding adaptation are much more narrow in settlement level energy management. One example is the conversion of energy provision systems in order to reduce vulnerability against extreme weather events that are expected to occur more often in connection to climate change.

In the case of energy modernizations and energy system improvements the aggregate effect of numerous aspects determines the real economic profitability of individual investments. The role of expenditures is lower here than in the case of traffic related improvements, since decrease in the safety of energy supply in itself can cause material damage, which exceeds manifold the cost of the initial investment. On the other hand better utilization of local energy resources reduces not only the one-sided dependence (both from financial and supply safety aspect) but can create new jobs and contributes to economic development as well. Apart from naturally considering other indirect economic effects, for example the decrease of costs incurred due to environmental loads and economic development due to savings, etc., determining the relation between investment costs and real profit is perhaps the most complicated in the energy sector. At the statement of profitability of the individual projects, related investments also play a significant role, therefore in most cases no general judgement can be made about a solution.

The implementation of mitigation measures in the mid- and long-term contributes to reducing the dependence of the EU on external energy sources, it may contribute to reducing the energy costs of local municipalities. Furthermore, mitigation measures may assist the strengthening of local cohesion, increase employment and the competitiveness of the region. Therefore the implementation of mitigation measures and co-benefits deriving from them largely overstep climate protection considerations.

6.1. MITIGATION OPTIONS IN SETTLEMENT LEVEL ENERGY MANAGEMENT

Climate conscious conversion of energy management of settlements – through the reduction of the emission of greenhouse gases – could significantly contribute to the mitigation of climate change. Mitigation possibilities may be put into two groups that are strongly connected to each other, at the same time can be clearly distinguished. One can be achieved through the increase of energy efficiency and savings by updating existing energy systems, as well as rational energy management and the decrease of energy end-use. The other main group of the mitigation options concerns the wider application of renewable energy resources that makes it possible the reduce the use of fossil fuels and thus leads to the reduction of greenhouse gas emissions. In order to reach these targets it is the task of the settlement management to develop an energy conscious settlement management system. This should be in accordance with the integrated urban development plan of the city and contain plans, financial and regulatory measures relevant to all energy related activities belonging in the competency of the settlement.

6.1.1. Energy-conscious settlement-management

Energy consciuos settlement management may be separated into two major action direction. The first and probably the most important is the shaping of an appropriate approach, which incorporates both decision-making as well as operation. The other target – deriving from the aspect changes – is the enforcement of technologies of high energy efficiency and energy-efficiency as horizontal principle both in the own activity of the local government and in case of other local economic actors including public institutions and households of the settlement. The third target is the promotion and incentivisation of the use of renewable resources to the possible greatest extent. Taking maximum considration of the aspects of these three targets the settlement management system can help to improve energy-efficiency significantly, which will lead to the reduction of energy consumption and reduction in the emission of greenhouse gases. All these aspects must be integrated into the public procurement process and supporting systems. Furthermore, they have to be taken into consideration when choosing technologies and materials applied in investments and during the operation of various machines and equipment. These action directions in settlements are equally valid for households, private and community services as well as for production activities.

Means of the energy-conscious settlement-management (Municipal Energy Efficiency Program of the City of Vienna, 2006-2015):

Development of an energy strategy

– In order to determine the objectives of the energy strategy a detailed situation analysis is to be carried out, by which the characteristics of the energy consumption of the settlement as well as the carbon dioxide and GHG balance shall be reveale. Furthermore the energy-saving and renewable energy potential of the settlement shall be defined.
– Determination of future vision and objectives of the settlement energy system; development of the energy supply and energy utilization options and choosing the most favourable for the settlement.
– Objectives conceived in the energy strategy have to be integrated with sector specific and horizontal (e.g. local transport, urban development, environmental, sustainability) strategies.
– As a part of the energy strategy, proposals shall be developed for the enforcement of aspects defined therein and for mainstreaming with other development documents. The integrated development plan of the settlement must be included in the latter by all means.

Energy conscious land use planning and local building regulation

- According to the principles and objectives set forth in the energy strategy for the enforcement of the energy efficiency and energy saving aspects (e.g. planting of tree rows for wind cover, orientation of street networks, modification of building regulations) revision of the land use plan and redesigning of the local building regulation is proposed.
- During obtaining the license of the building authorities the erection of buildings of low energy-use and the active (e.g. additional heating by solar collector) and the passive (e.g. orientation of buildings) utilization of renewable energy resources shall be preferred.
- In case of constructions or renovations the utilization of renewable energy resources should be made compulsory or incited in order to ensure the possible widest application – in consideration of the features of the settlement.

Redesigning of the local regulatory environment along the lines of energy conscious operation

- The cut-back and elimination of legal and administrative restrictions eventually hindering energy-efficiency and renewable energy investments is of primary importance, as well as the establishment of a climate-friendly statutory environment.
- Application of environmental and energy certification standards of suitable quality during operation of community organizations and buildings.

Continuous tracking of energy supply and use

- Continuous metering, tracking of the energy consumption and other relevant characteristics (technical characteristics, number of building users, function of the building, temperature data, volume and source of used energy, etc.) of municipal institutions.
- Establishment of an interactive, publicly accessible energy monitoring system for the entire settlement, based on geographical information system, equally comprising the data of the individual institutions, households and economic actors, in which the energy production and consumption practices, data characteristic for the entire settlement may be tracked.

Establishment of a financial incentive system supporting the application of sustainable energy solutions

- Redesigning of the local tax and fee system, elaboration of benefits for sustainable energy solutions (including energy efficiency and renewable energy).
- Elaboration of a support options for the increased application of renewable energy resoruces and for the promotion of energy efficiency investments.
- Establishment of a 'green public procurement system'.
- Establishment of a 'climate fund' for the settlement.
- Loan guarantee.

Awareness raising and information provision

- By organizing information campaigns and launching model projects successful energy efficiency and energy saving projects can be presented. Furhtermore, informing inhabitants and influencing consumption habits are also of great importance.
- The local government of the settlement can provide technical, legal, financial and tender advice to potential investors with regard to utilization of renewable energy sources and energy management. This contributes to information provision about sustainabel energy related objectives of the settlement, local resources and support possibilities.

Barcelona, Solar Thermal decree

Barcelona is the second largest city in Spain, with population combined with the agglomeration exceeding 3 million.

Barcelona was the first city in Europe that by a decree obliged house builders and owners engaging in building renewals by a decree to use solar energy. The draft of the so called 'Solar Thermal' decree was elaborated in 1998 and was accepted by the town council in 1999. The legal provision came into force in 2000 after a one-year moratorium.

The decree required first in case of buildings of an annual energy consumption exceeding 292 MJ, commercial buildings and buildings consisting of more than 16 apartments that in case of reburbishment or new building at least 60% of hot water demand should be produced by solar energy. Additionally the decree made obligatory that the complete heating demand of swimming pools must be covered from solar energy. Collaterally with the decree a support program was introduced for the owners and operators of smaller buildings to incite the increase of solar energy utilization. In 2006 the decree was modified, accordingly the annual limit of 292 MJ was revoked and the decree was extended to all new buildings or buildings to be refurbished, independently of the size or character of the building.

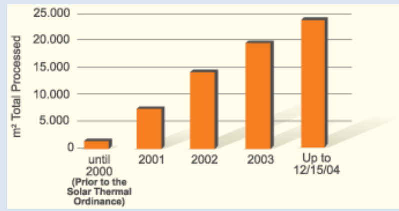


Figure 11: Change of the area heated by solar energy in Barcelona due to the "Solar Thermal' decree

As a result of the project annual carbon dioxide emission decreased by approximately 5,640 tons. Besides the sustainable energy modernization of privately owned real-estates the decree obliged also buildings of community ownership to utilize solar energy. By implementing these changes the city saved 220,000 EUR in operation costs due to efficiency improvments. Through the entry into force of the decree annual output of solar collectors reached 32,076 MWh. The energy agency of Barcelona city supports the implementation of the decree through education and information programs, counselling, and by engaging in continuous monitoring and controlling activity.

Contact:
Energy Agency of Barcelona
E-08012, Barcelona
Phone: +34/93/29148922
E-mail: tpujol@barcelonaenergia.cat
Web: www.barcelonaenergia.cat

6.1.2. Energy-efficiency and energy-saving measures, investments

Energy efficiency modernization of public buildings

Energy efficiency modernization of buildings is one of the best options for reducing energy use. The first step is to assess the energy consumption of municipal and community buildings. The second step is their modernization, taking into consideration the requriements of energy effciency. Chapter 7 of the handbook provides the details on refurbishment options. These are organized in a separate chapter as the modernisation of buildings appear mostly as individual interventions and no considerable differences can be identified between the energy efficiecy modernization of public and privately owned buildings. Energy efficiency modernization of buildings is characterized by long pay-back periods, meaning that resulting financial returns often occur only after a decade. At the same time their positive environmental effects manifest immediately after the completion of the investment. To support such investments it is necessary to develop central financing schemes and to establish loan-guarantee systems.

Improvement of the energy efficiency of public lighting

Modernization of public lighting is an important step in increasing energy efficiency at the settlement level. As part of Directive No. 2005/32/EC, accepted by the European Committee, Decree No. 245/2009/EC on environmentally friendly planning requirements of different lighting sources, forecasts energy-savings of approx. 38 TWh until 2020 for products under effect of the Decree. Within this framework inefficient lightbulbs and lighting fittings will be gradually withdrawn from distribution. Consequently, modernization of public lighting systems will become inevitable.

In order to improve energy-efficiency traditional light bulbs and lighting fittings used in public lighting systems shall be replaced by sources characterized by low energy consumption (e.g. sodium lamps, heavy-pressure sodium lamps, LED lamps). Furthermore, lighting fittings designed according to energy efficiency consideration shall be developed to enable sufficient focusing of the light source to minimize light loss.

Auroralia-prize

The prize was established by LUCI (Lighting Urban Community International). The organization was founded in 2002; its members are 63 cities from 4 continents, as well as emerging communities in urban public lighting, universities, public lighting experts and representatives of the lighting industry. The prizes are awarded in Lyon, France to cities that apply innovative solutions besides the incorporation of sustainability aspects. Application are judged by an international professional jury, with members coming from different parts of the world.

Applications are examined on basis of energy consumption, carbon dioxide emissions, total cost of the project, resources necessary for the production of the lighting system, transport, possibility of recycling, originality and beauty of the conception, its impact on the dwellers' life quality, social and cultural effects, health protection, improvement of the night view of the city and incentive effect of the project on other cities.

In 2009 the municipalities of Berlin, Lyon and Westminster won the high level award. In 2010 the first place was awarded to Budapest, the second place to Geneva and the third place to Tilburg in Holland. The first received 6,000 EUR, the second 3,000 EUR and the third 1,500 EUR.

Contact:
www.luciassociation.org
www.bliss-streetlab.eu/content/BROCHURE_AURORALIA_2010_ENG.pdf

In recent years LED-technology has significantly developed. The positive features of this technology are low consumption and prominently high service life, reaching even 100,000 hours. Those features enable the economic use of light sources connected to the electricity network or utilizing solar energy in public lighting systems. Installation of solar public lighting lamps is rather expensive, however their operating costs are very low. Therefore their installation is reasonable in areas where no electricity network is available.

Brasov, modernization of public lighting

The city of Brasov is located in the middle area of Romania in the Eastern edge of the Transdanubian basin, at the piedmont of the South Carpathian Mountains, with a population of almost 350,000.

In order to reduce settlement level energy consumption the local government of Brasov initiated the modernization of the public lighting system in 2002. Public street lighting as well as the decorative lighting of certain buildings was partially renewed. As a result of the investment the city saves yearly approximately 2,004 MWh of electricity, which is about a fourth of the earlier energy consumption. This means an annual saving of approx. 163,000 EUR, together with the annual saving of 70,000 EUR due to the reduction of maintenance costs. Total costs of the modernization amounted to 500,000 EUR, financed completely by the local government. In consideration of the significant savings, the investment amount will return very soon, thus the investment generates remarkable economic advantages besides the environmental advantages.

Contact:
Municipality of Brasov – Office for Public Lighting
Phone: +40/268/476793
E-mail: infopublice@brasovcity.ro
Web: www.brasovcity.ro

Modernization and establishment of district heating and cooling systems

Heat supply of buildings is accompanied by significant greenhouse gas and air pollutant emissions. Therefore improvement of the energy efficiency of heat supply is of primary importance for the mitigation of climate change. One possible solution is the establishment or modernisation of the district heating infrastructure, as it is characterized by essentially lower emission levels – in ideal cases – compared to individual heating., Furthermore the required energy can be produced more efficiently as part of combined heat and power (CHP) generating plants.

The advantages of district heating include:

- removing the heat source together with the associated heat and air pollution from the densly built interior zone area;
- ability to utilize large or exptensively large quantities of renewable energy and waste-to-energy sources that is impossible to do for individual consumers;
- more efficient energy utilization compared to individual and small consumers;
- in optimal case ability to supply not only heating but also air conditioning energy demand by renewable and waste-to-energy resources.

However, district heating systems can be rather obsolete – especially in the former socialist countries. Substantial losses may thus incur in insufficiently insulated apartments, as well as in out-of-date power plants and dilapidated infrastructure. These factors considerably deteriorate the environmental performance and competitiveness of such systems. Complex modernization including all elements of district heating systems is necessary to solve this problem. Proposals in this section focus on increasing energy efficiency of power plants and supply networks only. Energy efficiency refurbishment of apartments supplied by district heating does not significantly differ from that of apartments supplied by individual heating; therefore proposals for their modernization are discussed in Chapter 7 of the Handbook.

Diversification of energy sources must be a key consideration during modernization. For this purpose the possibility of utilization of renewable energy sources has to be explored (see Chapter 6.1.3 'Utilization of renewable energy sources at settlement-level'), as well. Out of the latter utilization of solid biomass and biogas ensures the best possibility to establish a district heating system. However, in areas characterized by suitable geological conditions geothermal energy can also be used. By application of renewable energy sources autonomous central heating plants can be established at the settlement level. These plants are independent of external energy sources and improve the competitiveness of the local economy by producing energy resources on site. They can contribute to the reduction of operation costs of public institutions. Furthermore they can increase own revenues of the local authority, if the district heating plant is in the ownership of the municipality.

During modernization of the district heating infrastructure the distribution system of the produced heat energy has to be optimized. Attention must also be devoted to the insulation of transmission infrasturcutre to the highest possible efficiency level, and to ensuring energy efficiency of the distribution centres.

Bansko, biomass central heating plant

The Bulgarian city of Bansko (with a population is approx. 10,000) is located approx. 150 km to the South of Sofia, the country capital.

The city of Bansko initiated the establishment of a district heating system based on solid biomass (especially silvicultural waste) in 2005. The aim of the investment was the setting up of an environmentally friendly heating system based on local energy resources with low cost demand.

The first block of 5 MW was handed over in 2005. In 2007 as the second phase of the investment another block with a capacity of 5 MW heat output was built. The woodchip-based central heating plant with a total output capacity of 10 MW supplies heat to 25 private buildings (hotels, dwellings and a church) and 20 municipal buildings, including schools, the kindergarten as well as the city hospital and museum.

The investment ensured remarkable advantages for the settlement, including economic and pollution reduction related benefits. Since commissioning of the central heating plant energy costs were reduced by approx. 50% and emission of pollutants decreased by 50%. It successfully saved annually more than 4,500 tons of carbon dioxide, 1,300 tons of methane, 1,700 tons of nitrogen oxide and more than 1,600 tons of sulphur dioxide. This can be regarded as a highly substantial result.

Contact:
Pro EcoEnergia Ltd.
BG-1000, Sofia
Phone: +359/02/9898950
E-mail: office@ecoenergia-bg.eu
Web: www.ecoenergia-bg.eu/content/en

Combined generation of heat and power (CHP)

Energy efficiency and competitiveness of district heating is greatly increased by the use of up-to-date cogeneration power plants. The essence of the technology is that power plants produce both electricity and heat simultaneously. Consequently two-thirds of the heat generated by traditional electricity production as waste heat may be still utilized. As a result efficiency of such equipment is extremely high, reaching 80 to 85% (35 to 40% electric, 45 to 50% thermal efficiency). Any energy resource used in heat production is suitable for establishment of the cogeneration system; accordingly it can be operated also by renewable energy resources.

The produced heat energy is gained in the form of steam or hot water. The transmission of heat to more remote locations is a more difficult compared to that of electricity. This is the reason why cogeneration power plants are primarily suitable for meeting local heating needs (heating and cooling of buildings, technological heating, water heating, district heating supply, etc.). For economical operation of these plants the existence of facilities in their proximity characterized by appropriate heat demand is crucial.

The high efficiency of the cogeneration systems can only be achieved if the produced heat energy is utilized. This can only be easily ensured during the heating season, however this condition is not unconditionally fulfilled during summer time. So-called trigeneration systems providesolution to this problem. They are suitable to satisfy the cooling demand of buildings and to reduce air humidity content by utilizing the produced heat via absorption technology. District heating systems can also be established using this technology, at the same timeas a result of efficiency reasonsit is better suited fornew buildings originally palnned to be connected to district heating, In other cases the cost of redisigning heating and cooling systems of buildings in order to be connected to the network can be exessivly high.

Modernization of power plants mostly exceeds the financial possibilities of settlements and settlement associations. At the same timedistrict heating is a key operative element of urban life. Therefore the local government is a primary stakeholder in developments concerning the district heating system, even if the investment is implemented by the state or a private company. Consequently the local government (among other stakeholders) can play a significant initiator role in suchinvestments. It may propose the modernization of the power plant to the owner (which may be the state), and it can participate in such tenders as a partner according to available means.

Timelkam, cogeneration power plan

Timelkam is a small city located in Upper-Austria, North of Attersee, with a population under 6,000.

The city of Timelkam in Upper-Austria can be regarded as a significant energy centre, as sevarl power plants are operating in the city. These power plants play an important role in the electric power supply of the entire province. Furthermore they supply district heating services for the city of Timelkam. In recent years significant investments were implemented for increasing energy efficiency, as well as for reducing pollution and greenhouse gas emissions. Within this framework the old, coal-fired power plant operating since 47 years was replaced by a state-of-the-art combined cycle, natural gas fired cogeneration power plant. Even though the new plant not based on renewable energy, it has a a remarkable advantage from the aspect of climate protection: it was implemented by the reconstruction of a rather obsolete coal-fired power plant, thus providing an example for the possibilities inherent in the modernization of less efficient, obsolete technology.

The electric performance of the new facility, established as a result of the project, is 405 MW producing capacity for electric power of 2,400 GWh yearly. Thiscan cover the needs of 700,000 households. At local level it is an essentially better result that the power plant supplies the heat energy for the urban district heating system. Heat performance of the power plant is about 100 MW, while the yearly produced heat quantity reaches 140 GWh.

From an environmental aspect a major advantage of the replacement of the former coal-fired power plant is that it significantly increased the efficacy of the power plant (59%) and the CO_2 emission per 1 kWh electric power decreased by two thirds. In addition the sulphur and nitrogen oxide as well as the particular matter (PM 10) emissions of gas-fired power plants are substantially lower.

Contact:
Energie AG Oberösterreich Kraftwerke GmbH
Phone: +43/05/90000
E-mail: service@energieag.at
Web: www.energieag.at

6.1.3. Utilization of renewable energy resources at settlement level

Under renewable energy resources we understand those wherethe available quantity continuously renews or reproduces. Energy resources may differ according to whether they are unconditionally and conditionally renewable. The first category includes energy resources available in unlimited quantity, such as geothermal, solar, wind, tidal and hydropower. Conditionally renewable energy resources – the reproduction of which requires human intervention – comprise biomass, waste and hydrogen.

In the last decade utilization of renewable energy resources has gradually increased in the European Union. By the Eurostat the total renewable energy production in 2008 exceeded the quantity of 148 million toe (ton of oil equivalent). This represents a more than 50% increase compared to the value in 1998 and exceeds 17.5% of the total energy production of the EU27. Among renewable energy resources the highest proportion was achieved by biomass and waste based energy production (69%), followed by hydropower (19%) and wind energy (7%). Utilization of geothermal and solar energy was relatively lower, reaching 4% and 1% respectively.

Priorities and action areas of the European Energy Policy accepted in 2007 aim at the implementation of three central founding principles: achieving sustainable development, increasing competitiveness and safety of supply. The achievement of these goals is greatly facilitated by the increase of utilization of renewable energy resources, inducement of the local economy, decrease of pollutant emission and reduction of energy imports. The so called 20-20-20 rule is a part of the Energy Strategy. According to itthe EU aims to reduce its greenhouse gas emissions by 20%, increase the proportion of renewable energy resources within final energy consumtion to 20%, and to improve energy efficiency by 20% until 2020. The Directive on Renewable Energy Resources accepted in 2009 serves as an instrument to fulfill these objectives.

The action directions set out in the Directive on Renewable Energy Resources requires decisively national level actions and measures to be determined in the national action plan. At the same time considerable results can be achieved at settlement level by local measures. These include the simplification of licensing procedures, promotion of knowledge transfer as well as active participation in investment or promotion of inducement.

It is abasic principle that individual renewable energy resources have to be utilized not individually, but in a complex way, by establishing a so called ‘energy mix’. Thus a stable energy system can be developed, which is less exposed to weather conditions and to constraints specific to the given energy resource. In smaller size – in case of small and middle-size cities – the development of an autonomous energy system can be targeted. This would ease external energy dependence of the settlement and ensure possibility to support the local economy and to develop competitiveness; Furthermore it would contribute to achieving social objectives. Renewable energy resources are particularly suitable to be included in such complex, diversified energy systems.

Güssing, establishment of an autonomous energy system

Güssing is located in the south-eastern part of Austria, in the district Güssing, near to the Hungarian border. Its population is about 4000.

Objectives of the project included development of the local economy, decreasing dependence on fossil fuelss, increasing competitiveness and employment creation. In 1988 the region of Güssing was one of the poorest micro-regions of Austria. Reason for this included the unfavourable location of the region, lack of larger industrial factories and the low number of jobs. In compliance with the decision passed in 1989 the settlement targeted entire independence from fossil fuels. Consequently, in coming years energy consumption of buildings in the settlement was optimized, enabling the city to achieve an energy saving of 50%.

Furthermore several heat and electric power plants relying on sustainable energy sources were established. Within the framework of the project the following facilities were built in the micro-region:

- wood fueled district heating plant in Güssing. the generated heat warms water in the central heating boiler, which is transported to consumers through well insulated transmission lines;
- cogeneration biomass power plant in Güssing that produces electricity and heat by innovative wood gasification technology;
- photovoltaic solar installment in Güssing;
- biogas installment in Strem producing thermal and electric energy from vegetable matters (corn, clover, grass);
- more than 20 biomass district heating plants in the district of Güssing.

The result of the project is an autonomous local energy system. The current degree of self sufficiency in the town of Güssing regarding heat and electricity is 100% (private households & public buildings). The Eureopean Center for Renewable Energy is an international accepted organisation which develops sustainable regional concepts. Güssing became an important research center with the focus on wood gasification technology. Several elements of the project were partially financed by the European Union.

As an effect of the complex local energy-management project the number of jobs and enterprises increased in the micro-region. Only in Güssing 50 new companies and 1,000 new jobs were created since the beginning of the project. This can mainly be attributed to the stable, calculable energy supply, which is cheaper compared to world market prices. The great number of created jobs improved manpower retention ability of the region. In connection this the formerly rather high commuter rate (70%) decreased.

The energy facilities decisively use local agricultural and silvicultural base materials. The fact that they rely on base materials produced locally led to the creation of new jobs. Furthermore old jobs became more stable. In addition to this conference and eco-tourism activities increased in the cityas a lot of people are interested in the good example. Sustainability is a key principleboth in the case of agricultural andsilvicultural activity. Plants are not cultivated in monocultures, accordingly the soil is able to regenerate. Attention is paid also to the appropriate renewal of the forest stand.

Contact:
Europäisches Zentrum für Erneuerbare Energie GmbH
A-7540 Güssing, Europastraße 1
Phone: +43 3322 9010 85020
E-mail: office@eee-info.net
Web: www.eee-info.net

Integration of renewable energy resources into the local energy management system and the establishment of the autonomous local energy system requires appropriate preparation. In order to identify all possible renewable energy resources a detailed survey of potentials is needed exploring the extent of the expected energy production for each kind of energy resource. Such a survey is necessary in order to define the conditions satisfying the emerging needs. The complex, diversifiedlocal energy management system has to be established by using the results of this survey, taking into account the aspects of climate protection, sustainability, energy efficiency and supply safety. This practice facilitates the improvement of economic competitiveness of the settlement, contributes to decreasing energy poverty, and improving climate protection.

Solar energy

Areas in Europe which are most suitable for utilization of solar energy are located in the basin of the Mediterranean Sea, as well as on the Iberian and in Balkan penninsula. Naturally this does not imply that the middle and Northern territories (except from the most Northern areas: the Norwegian and Scottish coasts) would not be suitable for the utilization of solar energy. The quantity of solar energy per square meter exceeds 1,000 kWh on average in Europe. The application of solar power systems is possible in most parts of the territory of the European Union. This is especially true in the case of more efficient solar collector systems. At the same time withphotovoltaic systems of 1 kW peak performance more than 750 kWhs of electricity can be produced in most parts of the EU.

The extent of solar energy utilization is continuously increasing in the European Union. Despite of this fact, according to Eurostat data, the share of solar power within total renewable energy production hardly exceeded 1% in 2008. The sspread of solar power is hindered by high initial investmentcosts and rather low efficiency, characteristic for photovoltaic systems. For compensation of these factors various support systems are applied in the EU-member states on the basis of Directive No. 2001/77/EC. Direct price support schemes(in case of electricity production) and investment support mechanisms are the most frequent forms of incentives.

Utilization of solar energy may occurin passive or active manner. The essence of **passive solar energy utilization** is that available solar energy can be utilized to the possible greatest extent without separate supplementary equipment, machines and tools, merely through the application of appropriate architectural orientation, as well as shading, efficient building insulation and suitable structural building materials. This way energy use can be reduced and energy efficiency may be increased. Passive solar energy utilization mainly facilitates the improvement of energy efficiency of the buildings. At the same time for example throughsuitable orientation efficiency of active systems can be increased as well.

Active solar energy utilization is constituted by those application modes that indirectly (e.g. solar collectors, solar power plants) or directly (e.g. solar cells) utilize the energy of sunshine. The most widespread application is heat generation by solar collectors, which is able to ensure the heating and hot water needs of residentialand public buildings. Furthermore electricity generation by solar cells is mainly suitable for smaller appliences. Both solutions are perfectfor smaller, decentralized and local energy production, and therefore constitute a key element of settlement level energy systems.

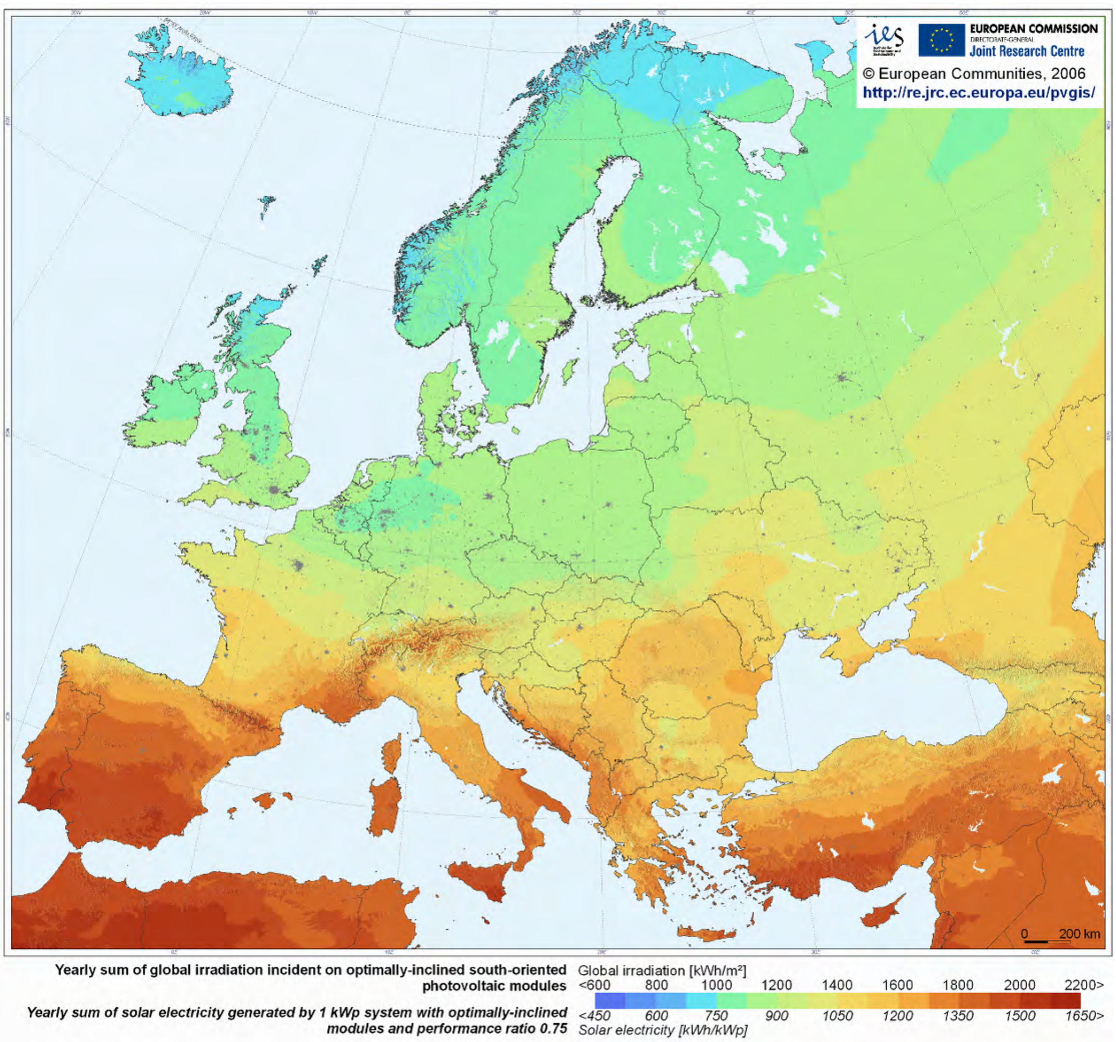


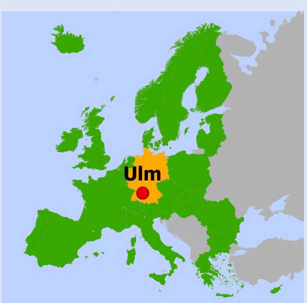
Figure 12: Extent of global irradiation and photovoltaic solar energy potential in Europe (source: sunbird.jrc.it/pvgis/)

The essential feature of **heat production by solar collectors** is sunshine warming the liquid circulating in the collectors. This in turn transfers the heat to heating and hot water systems of the building. This solution is primarily suitable to increase building energy efficiency. Solar collectors can be installed in clusters as part of energetic modernization of buildings. The installation of solar collectors – compared to heating based on traditional energy sources – is relatively expensive. However their operation carries many benefits and the expected service life of such systems is high, thus facilitating the return of the investment. Solar collectors can play an important role in the energy system of the settlement by improving energy efficiency of rbuildings in the community and of buildings owned by the local government. Installation of solar collectors on public buildings as a tool of energy-conscious settlement management can be a good example to the population and other investors. and can promote widening the application of this solution.

During **photovoltaic energy production** the semi-conducting material of solar cells transforms the energy of sunshine and light directly into electricity. The efficacy of solar cells is still rather low and their installation is very expensive At the same time due to electric power feed-in obligation systems established in several countries of the European Union, costs can be recovered easier in the long run. Solar cell power plants are suitable for insular or network based production, therefore they can be a useful part of the energy system of the settlement. In insular use it can cover the electric energy need of individual buildings, while in case of production for the network it may be part of the national or the local electric power grid. Production of solar cells is more calculable compared to wind power plants, as the quantity of sunshine is less fluctuating compared to wind velocity; consequently integration of solar cell power plants to the electricity gridis easier.

Utilization of solar cells in an urban setting is very advantageous, since there are plenty of free roof surfaces that are perfectly suitable for installation of solar cells. The individual utilization of solar cells may also have many advantages, as they can provide individual machines, and equipment characterized by low consumption (e.g. public lighting lamps or other devices of the traffic infrastructure) with electrictricity.

Thermal solar power plants transform solar energy to heat and by its further transformation generally produce electricity. Power plants transforming solar energy to heat characteristically concentrate solar energy (e.g. with parabolic mirrors or sun following mirror systems) and operate at extremely high temperatures. This solution is less suitable for local, decentralized electric power generation, since its establishment has rather high expenses, it is characterized by large space demand and such systems are technically complicated. Furthermore the scale of energy production does not adjust to these smaller systems either. However it must be mentioned that a thermal solar power plant is able to cover the entire electricity demand of a small town.



Ulm, utilization of solar energy

Ulm is located in the Southern part of Germany in the province Baden Württemberg. The population of the city exceeds 120,000.

The Sun constitutes an inexhaustible and pure form of energy. Therefore in the city of Ulm solar energy is utilized in addition to other renewable energy resources (including hydro power and biomass). Ulm and Neu-Ulm co-founded the Solarstiftung Ulm/Neo-Ulm foundation in 1995 with he goal of improving the framework conditions of renewable energy resource utilization in the region. The organization provides counselling and information services, as well as co-ordination among concerned parties. Furthermore it initiatiates projects.

The spread of solar energy utilizing systems and the increase in environmental awareness is greatly supported by the resolution of the City Council. According to the resolution on the roof of every public building which is suitable for utilization of solar energy solar cells or solar collectors have to be installed. Otherwise the surface itself has to be placed at the disposal of the inhabitants for installation of solar energy utilizing equipment. Widespread and large-scale application of renewable energy resources (including solar energy) is also supported by the resolution of the Supervisory Board of the municipal utilities (SWU Stadtwerke Ulm /Neu-Ulm GmbH). According to the resoltuion by 2020 100% of the electricity demand of all industrial works and households must be covered from renewable energy sources. In order to support the implementation of these objectives, in addition to the regulatory and investment support instruments, awareness rasing campaigns and information programs are also organized with theinvolvement of Solarstiftung Ulm/Neo-Ulm.

Due to the co-operation between the foundation, the City Council and the municipal utilities the total surface of solar collectors in Ulm reached 150,000 square meters by 2010, Thus the solar collector surface perinhabitant is 0.13 square meter, which is an outstanding value. Besides solar collectors the application of photovoltaic systems is also very widespread. Installed capacity of solar collectors reaches almost 13,000 kWs. Solar cell systems have been established so far on around 30 public buildings, starting withschool buildings and sport facilities.

Contact:
Solarstiftung Ulm/Neu-Ulm, D-89073, Ulm
Phone: +49/731/1616080
E-mail: info@solarstiftung.de
Web: www.solarstiftung.de

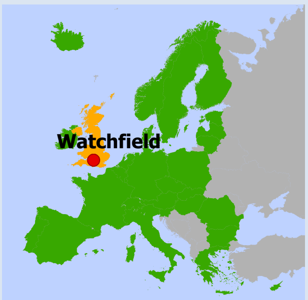
Wind energy

The coastal territories of Europe are the most suitable for the utilization of wind energy, however due to relief and meteorological characteristics also of inner territories of the continent can ensure good conditions for wind energy production. By the Eurostat the total wind energy production of the European Union increased tenfold since 1998, thus it exceeded 10,000 toe in 2008. The largest producers are Germany and Spain, being responsiblefor more than 60% of the total wind energy production of the EU. Since 2004 growth rate of wind energy output of the newly acceded 10 countries is far higher compared to the old member states. Wind energy production increased to the greatest extent in the Czech Republic, in Hungary and in Lithuania, by about twenty fold, partly due to the energy policy and support system of the European Union and the establishment of feed-in obligation systems.

One of the most significant problems faced by wind energy utilization is that wind velocity can be rather variable in time. Relatively constant wind velocity can only be expected only at coastal areas. A further problem is the frequent alteration of wind direction. Despite of the fact that wind power plants are adjusting to the prevailing wind direction, in areas characterized by highly variable wind conditions, the establishment of wind power plants with traditional horizontal shaft is less advisable (even if the wind velocity is appropriate). The height of wind power plants is generally between 75 and 100 meters. Therefore surface wind conditions are not decisive. As part of the comprehensive situation analysis and impact study to be conducted prior to the establishment of the wind power plant not only wind conditions but also the features of the electricity grid must be thoroughly examined. The resason for this is that these networks can hardly or not nearly balance the significant performance fluctuations without appropriate counterbalances (e.g. pumpe-reservoir based hydro power plant, or gas-fueled power plant, eventually hydrogen-based systems).

A new type of wind power plant- which could be very well utilized in settlement level energy systems- is the enhanced, low height wind power plant with vertical axle, reaching no more than 3 meter. The main advantage of this device is the ability to utilize wind of any direction. Furthermore, since enhancers can achieve a 9 to 25-fold wind energy increase, the rate of utilization may reach 60 to 80%. It is sutiable to utilize at the settlement level as it can be installed at optional sites, it offers suitable solution also for private persons, communities, apartment buildings (prefabricated buildings, residential complexes) to ensure safe electricity supply.

One possible utilization method is to use motional wind energy by directly applying **wind wheels** to operate machines (e.g. pumps). Energy produced by wind wheels applied as an individual solution can play a supplementary role in settlement energetics. Advantages of this solution include the replacement of electricity use in case of public institutions or dwellings. **Wind power plants** offer a more widespread solution that can be better applied in energy supplysystems of settlements. So called wind parks comprise several wind power plants transforming motional wind energy to electricity. Characteristic performance of wind power plants is nowadays between 1-2 MW but power plants with 3 MW or higher performance already exist as well. Wind power plants are particularly suitable to supply the independent settlement energy system. At the same time they can produce also for the regional or national network. Under appropriate circumstances this can solve the problem of fluctuating production as well. Should the settlement endeavour to establish an independent energy system, it can apply wind power plants in an integratedmanner, together with other – preferably renewable – energy resources that ensure the balance of the system and the safety of supply.



Watchfield, Westmill Wind Farm project

Watchfield is located in the county of Oxfordshire in South-East England with more than 2,000 inhabitants.

The Westmill Co-operative, with a present membership of 2,347, was founded in 2004 with the objective to ensure the supply of the local community with green energy. For implementation of this goal the co-operative decided to establish a wind farm comprising 5 turbines half mile far from Watchfield in South-England. The works started in 2007; in 2008 the wind power plant farm was ready for use. The installation costs of the turbines with a 25-year service life, amounting to 7.5 million pounds were financed from bank credit, collections and contributions of the members; the wind farm is in 100% ownership of the members.

The generators are 49 meter high; the length of their blades is 31 meter. The blades start to rotate at a wind of 3 m/s velocity; however at a too high velocity over 25 m/s they stop to avoid any damage. The performance of the individual turbines is 1.3 MW, thus the established performance of the farm is total 6.5 MW. The wind power plant farm ensures the electric power supply of 2,500 average apartments and saves yearly 5,000 tons CO_2.

Contact:
Westmill Wind Farm Cooperative
Phone: 01229 821028
E-mail: info@westmill.coop
Web: www.westmill.coop/westmill_home.asp

Geothermal energy

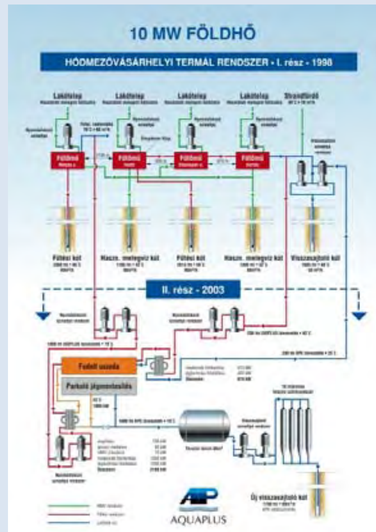
The proportion of geothermal energy production in total renewable energy production of the European Union is altogether 3.5%. This means that it constitutes the second smallest proportion after solar energy utilization. Reasons for this include unsuitable geological conditions, high cost of installationand complicated technology. Within the European Union utilization of geothermal energy is the most important in Italy. At the same time Hungary, although the utilization is less widespread here, is characterized by excellent potential due to favourable geological conditions and the high geothermal gradient.

Geothermal energy may be utilized in two main ways. When utilizing geothermal energy through **heat pumps** heat is extracted from an environment characterized by lower temperature and transported to a site of higher temperature. Thissolution, used exclusively for heat production, is able to porivde heating and hot water demand of individual buildings. At the same time geothermal energy is also suitable for larger scale application provided that e geological conditions enable the exploitation of thermal water suitable for energy utilization. This takes place through the establishment of **geothermal power plants**, which may provide the heat supply of a district or the cogenerated heat and electrictricityproduction of a settlement. Further advantages of the establishment of geothermal systems include supplemental touristic (e.g. thermal bath) and agricultural (e.g. greenhouse based crop production) applications through the utilization of residual heat. In this case a complexsystem can be developedinfluencing the economy of the entire settlement, through reducing energy costs, increasing revenues from tourism, and improving competitiveness of local agriculture.

Hódmezővásárhely, geothermic district heating system

Hódmezővásárhely is located in the South-Great Plain region of Hungary,, with apopulation exceeding 47,000.

The South-Great Plain region of Hungary is characterized by extremely highpotential for the use of geothermal energy. In order to exploit this potential, a geothermal public utility system was built in Hódmezővásárhely, which is intended to replace fossil fuels, reduce GHG emissions, anddistrict heating costs. The main feature of the geothermal public utility system is that in order to ensure heat energy and hot water supply the insulatedunderground transmission network connects the four independent district heating systems operating in residential areas, public institutions, as well as the bath and indoor swimming pool of Hódmezővásárhely.



The hot water supply system is based on two wells with a total depth of 1,300 m. High quality thermal water extracted from these wells - after degasification - will be delivered to 2,800 district heated houses, 10 public institutions (including the municipal hospital) and the sport swimming pool using pressure boosting pumps and almost 4,200 m of insulated transmission lines. This system produces annually approximately 170,000 m^3 hot water (resulting in a reduction of 23 TJ/year in natural gas consumption), which is only a fragment of the wells' capacity. The water used in the hot water supply system cannot be extruded back under the surface, so it is collected in the city sewage collection pool.

The geothermal heating system uses three producing wells with a total depth of less than 2,000 m and two thermal wells for reverse extrusion. Obtained thermal water with a temperature of 80 to 88^{o}C is pumped into heat substations connected to a 6,500 m insulated transmissionline network. This ensures the replacement of the entire circulatory heat loss of the hot water supply system and plays a determinant role in the satisfaction of heating energy supply requirements.

The end points of the thermal circuits are located on the territory of the city bath, where the repeatedly heated medium of an incoming circuit with a temperature of 40 to 45oC ensures the maintenance of a temperature of 27^{o}C in the open, 50 m pool, through a plate heat exchanger. The thermal water with a temperature of 27 to 30^{o}C, is then placed in a return extrusion well installed on site with a total depth of 1,700 m. The second incoming circuit satisfies the heat demand of the indoor swimming pool (3.2 MW) and ensures the defrosting of sidewalks around the pool. Then it is recharged back into the second well also with a total depth of 1,700 m. The entire heating system contributes to the city's annual heat demand with a heat amount of 110 to 120 TJ.

The project is considered beneficial both from an environmental as well as from aneconomic aspect, as it contributes to saving an amount of 4 to 4.5 million m^3 of natural gas. This development resulted in a significant reduction in the production costs of heat energy. The restricted self cost of hot water production and heating energy production (including reverse extrusion) is about 15 to 20% and 30 to 35%, respectively, compared tothe cost for production based on the use of natural gas. In addition to the above, a significant improvement in local energy security was also noted, since this system uses an import-independent and permanently available local energy source. Thereafter the city set the objective of meeting the entire energy demand of the district heating system using geothermal energy and further extending the system.

Contact:
HVSZ Zrt District Heating Service
H-6800, Hódmezővásárhely
Phone: +36/62/530930
E-mail: hvszrt@hodtav.hu; hvszrt@hvszrt.hu
Web: www.hvszrt.hu/tavfutes/index.php; www.termalenergia.hu

Complicated construction requiring accurate preparation, high building costs and the regulatory restrictions all poseproblems to the establishment of geothermal energy systems. It is a strongly restricting factor that the extracted thermal water has to be extruded back to the geological layers. Furthermore it must be ensured that the extruded thermal water is not polluted. Naturally this does not apply to the utilization of water for bathing purposes because in this case the exclusion of pollution cannot be ensured. However, difficulty can occur due to the high salt content of thermal waters and their higher temperature compared to surface-waters, whcih can damage plant and animal life; therefore special attention must be givern to environmental considerations.

Hydropower

In the past years no considerable expension can be observed in hydropower production of the EU, which represents almost 20% of the entire renewable energy production. However the use of low capacity hydropower is gradually gaining ground. As opppsed to large-scale hydro, their application may serve as a solution in atsettlement level energy management. Generallyat the settlement level neither appropriate conditions, nor the necessary resources are available for the establishment of a large-scale hydropwoerplants,.

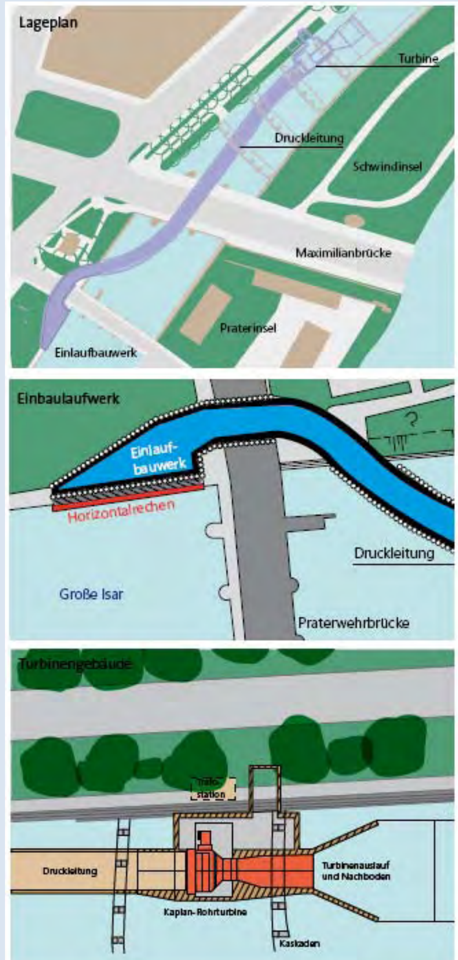
Small- (100 KW to 25 MW) and **micro-scale hydropower plants** (under 100 kW) can serve both water management and energy supply purposes. Their environmental impact is generally not significant. Due to the small performance level their importance is not considerable in the national or regional electrictricity production. At the same time they can be a very useful element of local energy supply. Further advantage include that their establishment does not require the buildingof large reservoirs; and often the renewal and redesigning of channels supporting older mills enables their installation.

If the settlement disposes of suitable potential, the utilization of hydropower can be deemed as a good alternative in the localenergy management system, since the production of energy produced in this way is relatively constant. With the help fo small scale hydro, production originating from other renewable energy resources- those strongly depending on fluctuating weather conditions - can be well balanced. Thus its use contributes to ensuring security of energysupply. Hydropower plants can also be applied as an environmentally friendly solution for energy storage by the establishment of **pumped-reservoir power plants**. For the implementation of the aims of sustainability and climate protection the reservoir should be filled withenergy generated from another renewable source.

Munich, low capacity hydropower

Munich, the capital of Bavaria is located in the Southern part of Germany. Its population exceeds 1,300,000.

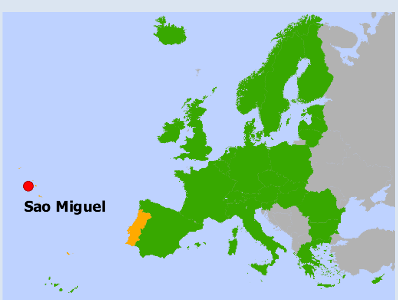
Utilizing the favourable hydropower potential the first such plant was established in Munich at the end of the 19th century. Currently six such facilities can be found on the Isar river crossing the city and 6 further water power plants are located in the surrounding of the city. These belong to the public utilities of Munich, their total built-in capacity reaching 119.3 MW. The latest hydropower plant is the 'Praterkraftwerk'. Its construction started in the spring of 2009 and it was handed over in summer of 2010.



The power plant was implemented as the investment of Praterkraftwerk GmbH co-founded by the municipal utilities and a company in private ownership. As part of the investment an existing dam was supplemented with a turbine. This, together with the relevant engineering structures is installed entirely underground. Thus the power plant, whcih is built in a highly frequented area of the city does not ruin the cityscape.

The new power plant with a peak performance of 2.5 MW produces 10 million kWh electrictricity annually, which is sufficient to supply 3,500 to 4,000 households and saves around 4,500 tons of CO_2 yearly. As a result of the investment total built-in capacity of hydropower plants operating in the city increased to 10.9 MW enabling an annual production of 55.1 million kWh electrictricity and the provision of more than 20,000 households.

Contact:
Praterkraftwerk GmbH
D-80336, München
Phone: +49/89/890668-21
E-mail: info@greencity-energy.de
Web: www.praterkraftwerk.de



Azores, Pico wave energy centre

São Miguel Island is the largest and most populous island in the Portuguese Azores archipelago. The island is 759 km^2 and has around 140,000 inhabitants, 45,000 of these people are located in the largest city in the archipelago Ponta Delgada.

It is a big challenge to ensure energy supply on the islands. The Portuguese government and other authorities set up a project to use a new kind of resource, the waves of the ocean. The climate-friendly power plant was planed on the island of São Miguel, next to the highest mountain in Portugal, the Pico. The construction was concluded in 1999, involving several Portuguese companies under scientific coordination of Instituto Superior Técnico. The operation of the plant is very simple: the incident waves cause vertical oscillation of the water column inside the chamber, which in turn causes alternate air flow to and from the atmosphere, driving the turbine and the generator attached to it.

In 2003 the staff of Pico Wave Energy Centre (named after Pico mountain) was ready to set the power plant in action. Since September – November 2005 and June - October 2006 regular performance tests have been undertaken, revealing the persistence of technical limitations of the structure. The Wave Energy Centre needs some technical adjustments. If these corrections are completed Pico can produce electric energy up to 7000 kWh. This amount of energy is enough for the cities of São Miguel or even other islands. This project can show us how to use our resources in alternative ways that we have not thought about before.

Contact: Wave Energy Centre
Av. Manuela da Maia 36, R/C Dto.
1000-201 Lisbon, Portugal
Website: www.wavec.org, www.pico-owc.net
Email: mail@wavec.org

Solid biomass utilization

Nowadays solid biomass is the most widely utilized renewable energy resource. It constitutes more than 63% of total renewable energy production of the EU. Its available potential is closely related to the agricultural potential of the region, keeping in mind that the raw material must be produced in a sustainable manner. Solid biomass is available as a by-product or waste of agriculture, silviculture and the timber-industry, and from plantations cultivated specifically with the purpose of generating energy. At the same time, solid urban waste – similarly utilizable as other types of solid biomass - may be included in this group as well.

In case of utilization of silvicultural and agricultural raw materials it must be a fundamental aspect that utilization for generating energy may not damage and jeopardize either the natural environment, nor security of food production and supply. Consequently, farming of energy crops (energy grass, energy forest) is recommended only in areas where the soil is of inferior quality and does not enable the production of food plants in suitable quality, furthermore it is not connected to a natural reserve area. From the aspect of energy utilization by-products and wastes of agricultural production are the most ideal biomass sources.

Decentralized energy production based on solid biomass has many benefits. It can ensure appropriate, secure and efficient energy supply of a settlement or region. Furthermore, the connected agricultural and silvicultural activities can significantly improve competitiveness of the local economy – especially in rural and agricultural regions – and facilitates employment creation, thus promoting the catching up of under-developed regions.

Solid biomass can be utilized in direct way for **heat energy production** through burning and also indirectly through chemical transformation. In this case vehicle fuels can be produced through fermentation to alcohol (**bio ethanol**) or through esterification of vegetable oils (**biodiesel**), Furthermore, **biogas** can also be gained through anaerob fermentation. Utilization of solid biomass in settlement energy management systems is recommended mostly in heat energy production or in the cogeneration of heat and electricity. Solid biomass can be used for this purpose directly – without pre-treatment or in pellet form –, or after fermentation in the form of biogas, as well.

Solid biomass is primarily appropriate for individual heating of buildings. At the same time based on this principle independent central heating plants can also be established, as part of modern systems cogenerating heat and electicity simultaneously. By establishment of a district heating system an independent local energy management system can be realized that may be able to sufficiently supply the total heating demand of smaller settlements. However, numerous examples demonstrate that it is worthwhile to establish such a system even exclusively for the heat supply of public buildings.

Lubań, biomass central heating plant

Lubań is a small town with a population of 22,0000, located in the Southern part of Poland.

Lubań started to modernize its district heating system in 1997 with the objective to reduce energy use of the city and air pollution caused by coal-fired boilers by introducing a new, environmentally friendly, straw-fired heat production system. The investment took five years, with the first phase taking place between 1997 and 1999, and the second phase between 2000 and 2001.

In the first phase 7 coal-fired boilers were eliminated and 7 new heat exchanger centres and network connections were built. Furthermore, the earlier existing 28 heat exchangers were modernized. One straw-fired boiler of 1 MW heat performance was built together with the relevant infrastructure (e.g. straw storage facility). In the second phase of the investment the system was extended by further boilers, during which two new boilers of 3.5 MW each were commissioned. In addition the serving infrastructure of the central heating plant and the machine park for straw preparation were developed. The installed capacity of the three straw-fired boilers is altogether 8 MW, their efficacy is 84%.

The total cost of the investment amounted to 1,608,275 EUR, out of which 43% was financed by EkoFundusz foundation as a donation. Further 20% was ensured by the Environmental and Water Fund (WFOŚiGW) in the form of a loan.

As a result of the project, price of the heat supply became controllable and stable. Annual average revenue from supplying heat is 7 million PLN. It can be regarded as a remarkable result that by the completion of the investment coal use was reduced to half, thus considerably reducing pollutant and greenhouse gas emissions. Heat energy produced by the district heating plant ensures heating for 60% of the population.

Contact:
PEC Lubań Sp. z. o. o.
Phone: +48/75/7224379
E-mail: biuro@pecluban.pl
Web: energy-bestpractice.eu/eng/lengy/main_pl_luban.html

Biogas

The extent of biogas utilization is no more than 5% of total renewable energy production in the European Union, thus preceding solar and geothermal energy production. The scale of its importance is equal to that of wind energy. Biogas is produced by fermentation, putrefaction of biological wastes. Raw material can be almost any organic biologically dissociable substance. By-products and wastes of agricultural and food industries as well as wastewater sludge mostly serve as raw material for biogas production. In settlement energy management systems primarily the by-products and waste of various utilities (wastewater treatment plant, waste treatment plant, holticulture) can serve as basis for biogas production. In leading agricultural regions agricultural waste and by-products originating from such activities in the surrounding of the city may be also utilized for biogas production.

Biogas generated through fermentation can also be used directly for heating of individual buildings, district heating or as fuel for cogeneration power plants. By further treatment of biogas biomethane can also be produced. This can be utilized as vehicle fuel or directly fed into the gas supply network.

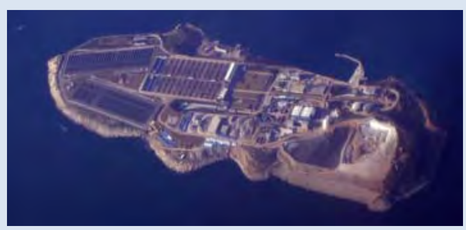
In settlement energy management systems the utilization of biogas – like solid biomass - is the most advantageous in **heat and electricity cogenerating power plants**. This solution can constitute a key element of an autonomous settlement energy management system. Besides electricity production it ensures the satisfaction of heat and hot water demand of the settlement in a calculable manner. **In smaller size** it can be applied for increase the energy-efficiency of the settlement's utilities as well as for independent energy supply. In this way operating costs of the service providers and parallel to this public utility costs of the population can be reduced.

Athens, utilization of biogas discharge from waste water sludge

Athens is the capital of Greece, its population with the agglomeration exceeding 3,500,000.

Europe's largest waste water treatment plant is located 1,500 meters from the coast of the Greek capital, Athens, on the island of Psyttaleia. The plant starteded to operate in 1994 and currently treats 750,000 m^3 waste water daily. Although the facility hindered the entering of waste water to the sea it did not offer an appropriate alternative for waste water sludge treatment. To solve this situation, the sludge treatment plant started its operation on 1 June 2007, ensuring disposal and utilization of waste water sludge.

In the waste water treatment plant a biogas-fired cogeneration power plant was built with the support of the European Union, using biogas discharging from waste water sludge to produce electricity and heat. At annual level the power plant produces 64 GWh electricity, covering the energy demand of the waste water plant on the one hand, on the other the surplus energy being fed into the electricity network. During the process heat is generated in addition to electricity, which is used for waste water sludge treatment and heating of fermentation containers.



Efficacy and usefulness of the facility is confirmed by several data sources. Since commissioning of the power plant methane emission decreased from daily 20,000 Nm^3 to 0.2 Nm^3, hydrocarbon emission reduced from 120 Nm^3 to 0.2 Nm^3. Furthermore, carbon monoxide and nitrogen oxide emission could be maintained under 650 mg/m^3 and 500 mg/m^3 respectively. The biogas power plant was implemented by co-financing by the European Union, its total budget amounting to 11,113,720 EUR. Own funds were ensured by the Water and Waste Water Treatment Company of Athens.

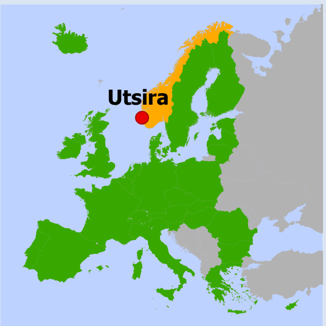
Further information:
Name of the organization: EYDAP-Akrokeramos Keratsiniou
Contact person: Moraitis I.
Phone: +30/210/7495834

Hydrogen based energy production

The Earth is characterized by the availability of large quantities of hydrogen. However hydrogen is not available independently, in pure form, only in its compounds (e.g. water, methane). Out of these compounds it can only be produced through using energy. Hydrogen can be generated through various processes (e.g. electrolysis, natural gas reforming, coal gasification). The most widespread method of is natural gas reforming, during which hydrogen is gained from methane. At the same time in this case CO_2 is generated in large quantities as a by-product. As this can hardly be harmonized with climate change mitigation objectives, the present publication does not discuss furhter the natural gas reforming technology. Production of hydrogen from hydrocarbons has a further disadvantage: by burning or applying in fuel cells hydrogen, produced through this method large quantities of 'new' – in the atmosphere not earlier present – water vapour is generated. Water vapour is also a greenhouse gas and effects of the increase of its concentration are not yet precisely known.

Another widespread method of hydrogen production is electrolysis. As part of this process, thorugh the use of electricity water molecules are decomposed into hydrogen and oxygen. Electrolysis fits with the considerations of climate protection only if electricity used derives from renewable energy sources. Hydrogen produced through this method is highly suitable for the storage of surplus electricity produced during so-called valley-period. Vallex-period indicates periods, during which energy consumption is the lowest during the day. During this period mamagement of electricity produced by less flexible power plants causes problems for the electricity grid system. During peak periods the stored electricity can be regained quickly and flexibly through burning or by applying fuel cell technology.

Several options exist for the application of hydrogen based technoligies. It can be used for example as vehicle fuel (see Chapter 5, 'Climate friendly urban transport'). Furthermore, in energy management of settlements hydrogen technology can be used for balancing fluctuations in electricity production. This can be necessary in the case of renewable energy sources subject to weather conditions or other factors and in the case of nuclear power plants during so-called valley-periods. In co-generation power plants (e.g. wind-hydrogen or solar-hydrogen) hydrogen increases efficiency, reliability and planning possibilities of renewable energy production. Thus it contributes to feeding energy originating from renewable energy resources into the national or regional electricity grid, and creates the possibility of establishing autonomous local electricity supply.



Utsira, establishment of a combined wind-hydrogen system

The settlement of Utsira with a population of 212 people is located on the island having the same name, 18 kilometres from the Southern coast of Norway.

Norsk Hydro, a Norwegian energy company and Enercon, a German wind turbine manufacturer built together a wind-hydrogen system on the island between 2003 and 2004 with experimental purposes. The plant has been operating since winter 2004/2005. The system provides electricity for 10 households of the settlement, i.e. it is a very small size. At the same time it can also operate at higher capacity and can be a solution for balancing the intensively fluctuating energy production in case of the individual renewable energy resources (solar and wind). It is also suitable for energy storage.

The advantage of the wind-hydrogen system compared to classic wind power plants is that during stronger winds the produced surplus energy will not be lost but it will be used for hydrogen production. The system consists of the following parts: wind turbine, accumulator, energy storage wheel, hydrogen container, electrolysing appliance, network connection station, as well as an energy balancing device and the fuel cell.

It is the main feature of the system that in case of stronger winds the wind turbines produce more electricity than required by the settlement. Subsequently the system uses the outstanding electricity surplus for the electrolysation of water, i.e. for production of hydrogen or – if there is no more demand on hydrogen production – it feeds the surplus into the national electricity grid. The produced hydrogen is stored in gas containers under high pressure. If the velocity of the wind is not sufficient – low or too high – and therefore the wind turbines do not produce electricity in a sufficient quantity, energy will be produced from the stored hydrogen with the help of the fuel cell.

Contact:
Hydro Oil & Energy – Utsira Project
Kjřrbovn 16.
N-1337, Sandvika
Phone: +47/22/538100
Web: www.hydro.com

Renewable Energy Sources (RES) Champions League

The RES Champions League composed by national RES leagues and local authorities set the target to motivate people and encourage them to exchange views and information with each other beyond the national borders.

The project started in September 2008 willing to popularise the solar energy application. Since that time the Champions League has been organised every year in 7 countries of the European Union. The aim of the project is to find the most active European settlements in solar energy application. Every city, town and village with a population of from a few inhabitants to a few million inhabitants can join the competition. Every year, the winner settlement is the one which has the biggest solar power system (solar collector and solar cell) per inhabitant.

The winner of the competition was selected based on three data:
- 1st: total area of the solar collectors in the settlement, m^2
- 2nd: total capacity of the solar cells in the settlement, kWh
- 3rd: total scores of the previous two data per inhabitant

The ranking is based on a simple ratio: installed power (or area) per inhabitant.

Three technologies of energy production from two renewable sources (solar, biomass) are eligible to the competition:
- solar category:
  - solar photovoltaic;
  - solar thermal.
- wood category:
  - collective heating systems and boilers (heat).

A European Championship Celebration is organised every year, more or less at the same time than the football Champions League final. The European champions of the 2010 season are, per size:

Division	European champions
General ranking: *all sizes*	1st: Prato-allo-Stelvio (Italy) 2nd: Schalkham (Germany) 3rd: Hostětín (Czech Republic)
Small cities: *from 5,000 to 20,000 inh.*	1st: Nowa Dęba (Poland) 2nd: Bansko (Bulgaria) 3rd: Montdidier (France)
Medium cities: *from 20,000 to 100,000 inh.*	1st: Neckarsulm (Germany) 2nd: Orosháza (Hungary) 3rd: Litoměřice (Czech Republic)
Large cities: *more than 100,000 inh.*	1st: Ulm (Germany) 2nd: Grenoble (France) 3rd ex-aequo: Częstochowa (Poland) 3rd ex-aequo: Plzeň (Czech Republic)

The partners of the RES Champions League network are involved in upgrading the competition by generating new ideas and by shaping the rules that apply for it.

Contact information:
E-mail: contact@res-league.eu
Web: www.res-league.eu

A more common exploitation of renewable energy resources such as wind or photovoltaic energy, or the wide-spread use of home-charged hybrid cars cannot be achieved based on the ordinary electric power grid system. In order to handle the rapidly changing consumption or energy production by individual users, an intelligent system is needed which can provide real-time data. A **smart grid** relies on two-way digital communication between the consumers and suppliers of electricity. This makes it possible to synchronise production and consumption in a more precise way. The European Technology Platform SmartGrids defines smart grids as electricity networks that can intelligently integrate the behaviour and actions of all users connected to it - generators, consumers and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies. It is not a new grid system, but the evolution of the existing one. The smart grid includes an intelligent monitoring system that keeps detailed track of all electricity flowing through it. It has the potential to integrate renewable energy more effectively than the traditional system. When power is the least expensive, the user can allow the smart grid to turn on selected home appliances, while at peak times, it can turn off selected appliances to reduce demand. This could save energy, reduce costs and increase reliability and transparency.

The smart grid is ideal for national grid systems, but it can be implemented at the local scale, for example in a city, too. The world's largest smart meter deployment was undertaken in Italy with a coverage of over 27 million customers; but in the UK, the Department of Energy and Climate Change announced its intention to have smart meters in all homes by 2020. The European Union, to make low-carbon technologies affordable and competitive, launches the European Strategic Energy Technology Plan (SET-Plan). This plan includes the Smart Cities Initiative, which supports the implementation of smart grids, too.

6.2. ADAPTATION POSSIBILITIES IN THE ENERGY MANAGEMENT OF SETTLEMENTS

Adaptability of a region or a settlement refers to the stenghtening of its resilience and reduction of its vulnerability to the impacts of climate change. The effects of climate change may considerably vary in different regions; consequently it depends on local characteristics, what type and extent of change a given settlement must be prepared for. During the development of the settlement energy strategy, as part of the founding examinations, expected impacts of climate change affecting the settlement shall be assessed. Adaptation measures of the settlement energy management system should be designed accordingly.

The relevance of settlement energy managment systems is higher in case of mitigation measures. The scope of adaptation options is far narrower since energy systems are more suitable to reduce greenhouse gas emissions and strengthen mitigation efforts. However, this can be done in line with the adaptation needs of a settlement. The establishment of autonomous settlement energy management systems can contribute to improving the resilience of a region or settlement by strengthening the competitiveness of the local economy and by reducing dependence on external factors.

As an effect of climate change various extreme weather conditions will become more frequent, intense and longer. This can cause serious problems in energy supply systems, especially in electricity lines. It must be examined which extreme weather condition are most likely to occur in the specific region. Energy supply systems must be developed and modernized accordingly.

Energy consumption – mostly during heat waves – will significantly increase, proportionately with warming. For this reason in order to reduce the increase of energy consumption and to facilitate adaptation to changed weather and climate conditions, review of settlement-level physical plans and local building regulations is recommended. As part of this, attention must be paid to the incentivisation of passive energy utilization and energy saving. Suitable orientation and optimization of the street network and buildings, application of green roofs and planting tree rows for wind protection can greatly enhance adaptation. These measures can decrease the energy demand of individual buildings, decrease total energy consumption of the settlement and release the load of the settlement energy system.

During extended hot periods during the summer energy consumption remarkably increases due to the increased spread of air conditioning. During summer (which is expected to get warmer because of the effects of climate change) and during the course of increasingly warmer and longer heat waves the load of energy systems can be extremely high. Therefore in order to avoid more serious breakdowns and to safeguard the security of energy supply, it is recommended to prepare energy production systems in order to be able to appropriately satisfy energy consumption peaks during the summer.

Because of extreme wind force, storms and thunder occuring mainly in summer periods, replacement of electric air cables by ground cables could be a solution, especially in urban wind channels. The break of air cables during winter periods due to frost damage could be also avoided through the application of ground cables.

BRIEF RECOMMENDATIONS

- Increasing the share of renewable energy sources (solar, wind, hydro, geothermal, biogas, solid biomass utilization, hydrogen-based energy production).
- The climate aware transformation of urban energy management by reducing the emission of greenhouse gases.
- Increasing the energy efficiency and saving energy (public lighting, modernizing the energy systems of local institutions).
- Improve the efficiency of he municipal power supply systems. Conversion and regulation in order to reduce the vulnerability the more frequent extreme weather situations.
- Creation of energy aware settlement-management system.
- Creation of energy strategy.
- Development of energy aware urban structure planning, land-use planning and local building regulations.
- Transformation of local regulation policy in order to increase the energy aware operations.
- Energy development.
- Developing a system of financial incentives (local tax and system, ‘Green public procurement system’, local climate fund creation).
- Creating autonomous municipal energy systems for small and medium-sized cities.
- Support the passive use of energy and energy-saving.
- District heating based on renewable energy and waste to achieve.

7. CLIMATE AWARE ARCHITECTURAL SOLUTIONS

Building-energetics is one of the major priorities of the European Union's energy and climate policy. Directive 2002/91 and directive 2010/31 of the European Parliament and of the Council on the Energy Performance of Buildings (EPBD) specifies, inter alia, that after 2020, or in the case of public establishments after 2018, only buildings with **nearly zero** energy consumption will be granted planning permission. It is also a mandatory specification that as of 2012, no support can be granted to new constructions or renovations not fulfilling the minimum requirements calculated according to the **cost optimum,** as to be later defined by the Commission.

Directive 2006/32/EC on energy end-use efficiency and energy services specifies that member states elaborate an Energy-efficiency Action Plan for the period up to 2020 and specifies buildings, transport and public institutions as the main sectors. The common climate and energy policy has set the objective of a proportion and a growth of 20% in the field of energy saving and in renewable energy, respectively, at the EU level by 2020. It is important that in its resolution of 17 November, 2009, the European Council made it clear that the developed industrial countries have to reduce their greenhouse gas emissions by 80% by 2050. The major pillar of this decarbonisation process is achieving a significant decrease in energy consumption – and consequently in CO_2 emissions -- related to buildings. But the sustainability and climate-friendly strategies and solutions relate not only to energetics but also to water management and aspects of green architecture (green roofs, green fronts, etc.).

7.1. FOSSIL ENERGY CONSUMPTION OF EXISTING BUILDINGS

The energy consumption of buildings depends strongly on climate. Logically, in the northern part of Europe ensuring the ideal internal temperature is necessary mainly during the winter season, while in the Mediterranean region, this is more necessary in summer. The largest, central part of Europe stretches over the border areas of the temperate and continental climatic zones. Consequently, the summer and winter temperatures can be very extreme, so emphasis has to be laid both on cooling and heating, as well as on sun protection when designing buildings. With their long-established form and construction materials, traditional buildings have adapted well to local climates in every region of Europe, although, it must be said, at a comfort level significantly lower than today's. However, modern architecture and contemporary life styles have broken away from local climatic features. The modern man satisfies his heat comfort demand, which is considerably higher than in previous times, with more and more sophisticated machinery. The operation of these entails higher energy consumption, which leads to the fast exhaustion of fossil energy resources and, through CO_2 emission, significantly affects global climate change.

Over the past decade, significant changes have taken place in the relationship between the natural and built environments. Rising levels of demand, increasing individual consumption and a growing population combined have resulted in an exponentially increasing burden on the environment, a significant part of which is related to the creation and maintenance of the built environment. 7-800 years ago buildings consisted only of the main structures, and were durable. Since the beginning of the 20th century, the proportion of more quickly aging engineering and professional industrial solutions has become predominant in a building. This requires cyclic reconstruction and modernisation. Clearly, the main direction of technological development is HIGH TECH and intelligent buildings, but processes can also be observed which are going in the opposite direction, with the objective of minimising mechanical engineering and technology, and prioritising passive and semi-natural tools and LOW TECH. In certain cases intelligent buildings and building automation are inevitable; but the more sophisticated a system is, the more vulnerable it is. Passive architectural solutions, e.g. passive heating-cooling-ventilation, natural lighting, etc., ensure that buildings perform their basic functions even in the event of power cuts and electronic disturbances.

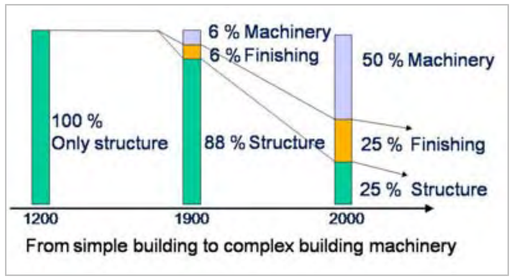


Figure 13: Lifecycle cost analysis (Czerny J.)

Currently, **heating** still constitutes the highest energy cost to residential buildings. In Hungary, the heating of residential and public buildings represents 32% of total CO_2 emissions! Due to the rise in average summer temperatures and the increasing extremities, besides those buildings demanding a high level of comfort and are already fitted with air-conditioning (e.g. hotels, office buildings, theatres), other types of buildings, including residential houses, have had masses of cooling equipment installed instead of proper sun protection. Even in statistics, this issue is not handled in its own right, despite the fact that this subject is gaining increasing significance. In the case of certain residential buildings and all modern office buildings, the cost of cooling energy exceeds that of heating, and the cooling demand prevails when preparing the mechanical engineering designs. Typical cooling equipment is powered by electricity, so their primary energy demand is high, and since a significant proportion of electricity is produced by burning gas and coal in power plants, their CO_2 emissions exceeds those from using gas or solid fuels for heating.

When examining energy use and environmental load, it is important that we not only consider the consumption occurring during the usage of buildings but also throughout their entire life cycle. In the course of **Life Cycle Assessment**, the total environmental load of a building is calculated starting from its construction, through its operation and necessary maintenance, to its demolition.

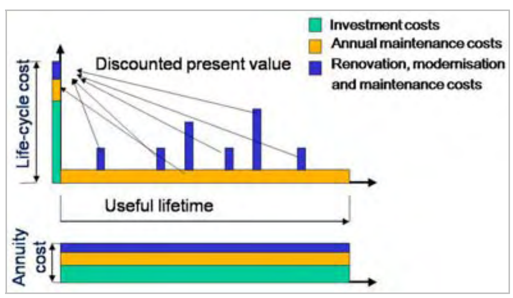


Figure 14: Costs related to the buildings (Czerny J.)

The amount of energy consumed in the establishment of buildings includes the energy spent when producing the construction materials and when transporting them to the site. A sustainable settlement strategy, or structure and land use plan, can determine the maximum built-in energy content to be achieved in the case of a new construction. Priority has to be given to local, natural and recycled construction materials. At the same time, maintaining an existing, poor-quality building demands a significantly higher amount of energy than that energy spent on the production of the materials and on construction.

Buildings' sustainability not only means environmental but also economic sustainability. Thinking in life cycles takes the entire environmental load of the building into account, including utilisation after demolition. The cost analysis calculates all the costs of the entire life cycle, i.e. construction, operation, cyclic renovation, modernisation and demolition, in advance, at today's cost. Hence, we can get a picture of the following even before the commencement of the project:

– will the user be able to maintain the building after its construction?
– how long will it take to recoup expenditure in energy-efficiency and renewable energy?
– by how much do these devices or solutions reduce life-cycle costs, i.e. how much more expensive would operation be without having invested in their installation?

This calculation is especially essential from the dual perspectives of the national economy and the state of the environment, as it provides the means to achieve permanent and full sustainability. This cost calculation is gradually becoming part of the toolkit of property developers and facility maintainers, and it is expected that it will become one of the requirements of public procurement, from where it will spread to the wider industrial - construction praxis.

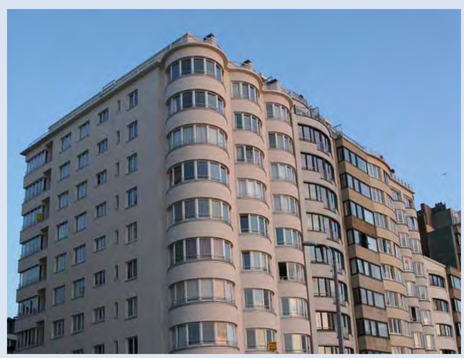
Ostend, construction consultancy and loans

The city of Ostend lies along the coast in the north-western part of Belgium. It has approx. 70,000 inhabitants.

The city of Ostend established an organisation called EOS (Energy Saving Ostend) to reduce individuals' and organisations' energy expenses. In order to achieve this the organisation provides free consultancy and even gives loans with favourable conditions.

EOS experts examine 700 households every year to assess the condition of the houses in terms of energy management. Every household is given a free programme package including useful energy-economic products. The professionals also make recommendations on how to cut the buildings' energy consumption.

The actual implementation of any given advice will, of course, be expensive, so the organisation also helps its clients with interest-free loans. The organisation gets 2% loans from FRGE (Fonds ter Reductie van de Globale Energiekost – Fund for Reducing Global Energy Costs), an institution supporting energy-cost reducing projects, but the city takes on paying the interest, so this is why EOS grants loans free of charge. The loan can be a maximum of € 10,000 and has to be paid back in 5 years.



Contact:
Bart Van Camp, EOS
E-mail: Bart.vancamp@oostende.be
Web: www.oostende.be/eos

7.2. ARCHITECTURAL POSSIBILITIES FOR MITIGATING CLIMATE CHANGE

Every settlement needs a **sustainable development strategy**, integral parts of which are its energy strategy and its climate strategy. A settlement is part of the land, the land supplies the settlement with power resources and the settlement returns this with services and products. A sustainable settlement lives in balance and symbiosis with the surrounding land providing for its needs. To achieve this, firstly the land's ecological balance has to be defined, and then a strategy needs elaborated to restore this balance, based on sustainable use of the land. Sustainable land use means - contrary to sectoralised, industrialised agriculture - organic and biological agriculture, where the cultivation of plants and animal husbandry constitute an organic unit. Biological farming puts an end to the overuse of the land and soil, and introduces their rhythmic rejuvenation. Sustainable forestry is also part of this kind of economy.

Due to the above reasons, the preparation of the energy strategy has to be preceded by the examination of land use in the inner and outer areas of the settlement and then by the elaboration of a strategy for switching to sustainable land usage. The energy strategy has to be prepared alongside this strategy. The first step of preparing a strategy is assessing the entire renewable energy and energy-efficiency potential, in light of which the energy-efficiency actions can be drafted. Subsequently, it is possible to construct alternative energy models based on knowledge of the economically exploitable renewable resources and then, examining their feasibility, to prepare proposals and a strategy. The final objective is to develop a vision to implement the settlement's energy-independence within a 20 to 30-year timeframe.

Assessing energy potential means estimating or calculating the exploitable quantity of all types of renewable energy:

- solar energy potential: calculating the amount of surface suitable for the energetic utilisation of solar energy and their performance potential, which are:
  - well-oriented high-roof surfaces, flat roofs;
  - noise barrier surfaces that can be located along linear establishments (railway, express highways, motorways);
  - areas unsuitable for other purposes.

Figure 15: 17 hectare PV field, Burgtonna, Austria

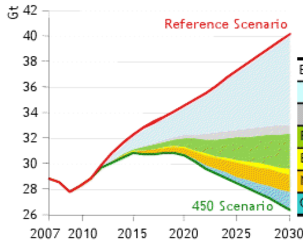
- biomass potential:
  Data on solid and liquid, primary and secondary biomass quantities and their energy yield:
  - firewood and forestry waste;
  - agricultural waste: green waste, liquid dung, etc.;
  - yield of energy plantations;
  - organic content of communal waste;
  - communal and industrial wastewater.
- wind-energy potential:
  Categorisation of places suitable for producing wind energy in the inner and outer areas of the settlement; the amount and performance level of installable equipment.
- hydraulic energy:
  Estimating performance based on fall data and the opportunities for damming creeks and rivers suitable for producing hydropower.
- geothermic energy
  Potential of thermal wells; performance data of the cascade-system utilisation; possibility of deep geothermic utilisation (Hot Dry Rock – HDR – technology) for the purposes of a large power plant.

All these potentials can be examined on smaller units scale, e.g. a residential block, plots of land, too. The locally produced energy reduces the ecological and carbon footprint of the area.

Energy-efficiency potential

To decrease energy consumption and, consequently, buildings' CO_2 emissions in a city, the first step should be mapping the quality of the existing building stock. This is the duty of the city management, the energetics expert and the engineer-in-chief, or the settlement's chief architect. Increasing energy efficiency has the greatest potential to decrease CO_2 emissions and a proper picture of this could be obtained if the buildings' energy certificate were available.

It would be important to establish a **spatial information system and database** extending to plots and buildings, into which data on building stock could continuously be uploaded. However, until this is available, an energetics audit could be prepared on the entire stock of buildings or part of it, e.g. on public buildings.



	Abatement ($Mt\ CO_2$) 2020	Abatement ($Mt\ CO_2$) 2030	Investment ($2008 billion) 2010-2020	Investment ($2008 billion) 2021-2030
Efficiency	2 517	7 880	1 999	5 586
End-use	*2 284*	*7 145*	*1 933*	*5 551*
Power plants	*233*	*735*	*66*	*35*
Renewables	680	2 741	527	2 260
Biofuels	57	429	27	378
Nuclear	493	1 380	125	491
CCS	102	1 410	56	646

Efficiency measures account for two-thirds of the 3.8 Gt of abatement in 2020, with renewables contributing close to one-fifth

Figure 16: World abatement of energy-related CO_2 emissions in the 450 scenario (OECD-IEA, 2009)

The most important data concerns heated floor space, the nature of the main building structures and the annual energy consumption based on utility bills. In possession of this information, the buildings' energy-efficiency can be calculated to a good approximation. It is expedient to determine heating energy demand first in kWh/m^{2}a, which can be completed with the data about the cooling energy demand and electricity consumption.

A data sheet to be filled in by surveyors has to be prepared for each building.
Major data:

- heated floor space of building in m^2;
- wall structure;
- type of window;
- energy costs for 1 year;
    - heating (gas, firewood, etc.);
    - electricity (heating, cooling).

A simplified method is sufficient for preparing a strategy. Data on the following has to be collected from the whole settlement (settlement part):

- number of households;
- number of persons;
- annual heating demand;
- annual sanitary hot water demand;
- energy demand of industrial establishments (heat + electricity);
- energy demand of agricultural establishments (heat + electricity);
- energy demand of commercial establishments (heat + electricity);
- energy demand of public buildings (heat + electricity);
- electricity demand of public lighting;
- total heat demand (heating + sanitary hot water);
- total electricity demand.

It is possible to categorise the buildings according to their energy class and total energy demand based on the collected data. Some help in this is provided by the table by PHI indicating domestic hot water and electricity demand in addition to heating demand. In the table, the last one is the 'zero' (i.e. autonomous) house.

Based on the building stock's energetics data, the amount of energy that can be potentially saved with energy-efficiency measures can be determined with good approximation. As a decrease in emissions can be achieved in the most cost-efficient way through energy-efficiency, the primary task is to prepare an energy-efficiency action plan. This is the primary condition for using renewable energies. The savings potential of the existing stock of buildings can be achieved in 20 to 30 years. A complete switch, i.e. setting the objective of establishing a sustainable and energetically independent settlement, can be implemented in 30 to 50 years, provided that a good strategy exists.

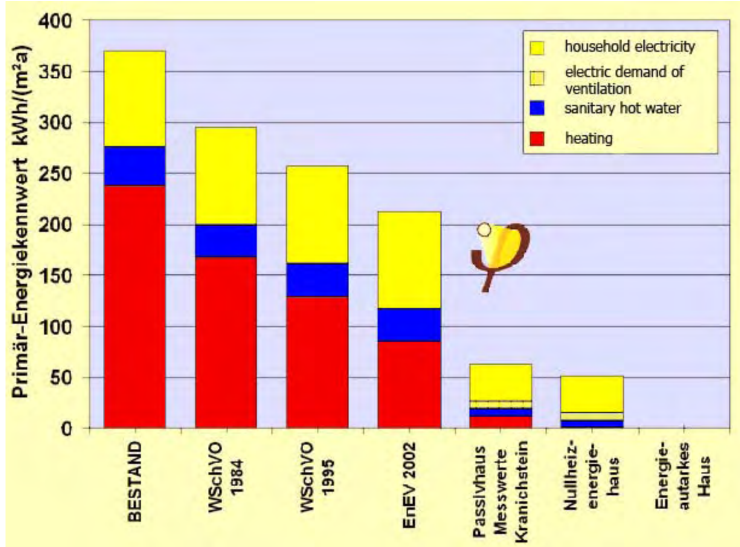


Figure 17: Comparison of energy ratings of homes (Passive House Institute)

Quick and spectacular results can be achieved by switching public lighting to LED+PV operation. LED lighting fixtures already include streetlamps with outstanding energy saving features. Low consumption allows the energy needed during the night to be collected by a post-mounted photovoltaic unit and stored by a battery. This way public lighting operates independently from the network, using a dusk-switch. The action plan includes the elaboration of a funding programme which, with complementary support from the EU, provides financial assistance from local sources, e.g. with interest-free credit to ensure the own-contribution for the funding schemes, accelerated planning permission, local tax benefits as well as by supporting the domestic energy-efficiency industry. Besides carrying out a survey from 'below', it is practical to perform the status survey from 'above', i.e. starting out from the energy consumption data of the entire settlement, from statistical data.

We have limited possibilities for reducing energy consumption in respect of our existing buildings, but in the case of new buildings it is useful to take the energy-conscious design principles into account in the initial design phase; this way low energy usage can be developed much more easily, cheaply and efficiently.

Naturally, the entire year has to be taken into account in respect of energetics and heat. It is important to emphasise this as recently the energy-conscious approach has been mostly concerned with reducing heat energy consumption and by increasing solar heat gain. However, the objective is to find solutions reducing primary energy demand throughout the year, ensuring a pleasant heat comfort for the users. When possible, designers have to ensure the appropriate internal heat comfort by 'natural' passive architectural and structural means, because of the significant primary energy demand of mechanical cooling.

The energy demand for heating consists of the balance between the following factors (J. Várfalvi, A. Zöld, 1994):

- **transmission heat loss:** subject to heat transmission factors of the bordering structures and to thermal bridges;
- **ventilation heat loss:** heat loss originating from filtration and artificial ventilation;
- **solar heat gain:** subject to orientation, proportion of glazing, shading and the energy transmission characteristic ('g' value) of the glazing;
- **heat gain from internal heat sources:** depends on the number of people staying in the building, the equipment used and the artificial lighting.

Besides energy for heating, the demand for domestic hot water (DHW) also needs mentioned, which is permanent throughout the year and independent from the structure of the building. The most general solution for supplying DHW is preparing hot water with solar collectors, which covers the demand in ¾ of the year. Among passive houses, a 'compact device' is spreading, which not only ensures heat recovering ventilation but also produces DHW from the heat extracted from the escaping air with the help of a heat pump. Heating energy demand can be decreased, logically, through the following factors:

- by heat insulation and reducing thermal bridges;
- air-tight structures and heat recuperation (by making doors and windows air-tight and with ventilation devices);
- by increasing solar gain (by constructing solar traps and increasing glazed surfaces).

It is expedient to cover the remaining heating demand with highly efficient, regulated heating relying on renewable resources.

7.2.1. Energy conscious construction

The first step in reducing transmission heat losses, in addition to achieving an optimal surface/volume ratio, is the intensive **heat insulation** of all the external structures of the building and those bordering unheated spaces. As well as this, and in order to avoid mould, it is essential to stop or decrease the impact of heat bridges, which can be achieved by placing insulation on the external sides of the bordering structures. Fashionable terraces with reinforced concrete consoles and the shading concrete slabs are typical thermal bridges.

Figure 18: Dresden, housing estate rehabilitation, reducing from 6 to 3 storeys, independent terraces

Solutions used for avoiding thermal bridges:

- thermal bridge-free consoles interrupting the heat-conductive structure, i.e. the terrace slab,
- development of a terrace structurally detached from the building.

Programme for improving energy efficiency in Slovakian households

Housing refurbishment and modernisation is among the long-term strategic priorities of the national housing policy in Slovakia. One of the aims is to achieve gradual decrease of energy consumption of buildings subject to the provision of the Act No. 555/2005 Coll. on the Energy Efficiency of Buildings. Many buildings in Slovakia were constructed during the soviet era; these houses are not energy efficient at all. In 2009 to improve efficiency and to reduce the emission of carbon-dioxide the Governmental Insulation Programme was launched. The programme was managed by the Ministry of Transport, Construction and Regional Development and involved all Slovakian cities. The programme provided beneficial loans (0% interest rate, total fund of 70 million EUR) for a complete insulation of residential buildings. Funding was provided from the emission trading, loans were administered by the State Housing Development Fund. The financial resources were spent for more than 350 projects representing 14 775 housing units. As a result the calculated decrease in energy consumption of insulated residential buildings was more than 40%.

This programme can be ideal for cities, which have buildings with low energy efficiency and where the residents need a financial assistance to restore their homes.

Contact:
Prievozská 2/B, 825 25 Bratislava 26
Phone: +421 (0) 2 583 17 111
Web*:* www.build.gov.sk/mvrrsr/index.php
E-mail: elena.szolgayova@mindop.sk

Proper doors and windows are an important part of well heat-insulated wall structures. Today's modern heat-insulating triple-glazed doors and windows are practically equivalent to the external walls in terms of energetics. However, in certain cases it is risky to install excellent quality doors and windows because, if rooms with air-tight doors and windows are not sufficiently ventilated, then the humidity of the internal space can quickly increase and the air becomes stale. Vapour may cause periodical condensation on the internal surface of thermal bridges, which, in the long term, leads to mould. Because of the lack of air exchange, ventilation becomes more frequent, which results in an increased heating demand. The decreased filtration loss requires a proper air exchange is ensured.

Winter heat loss can be further reduced primarily by decreasing **ventilation heat loss**. The basis of low energy consumption is a favourable surface/volume ratio, an airtight design extending to the entire external space delimitation, mechanical ventilation with heat recovery and an air exchange matched to the temperature (preferably, not too high). The entire building shell has to be designed in an air-tight manner, with particular regard to the installation of doors and windows. However, all joints are critical, so this is why it is necessary to apply air- and vapour-tight foils and barriers. Heat recuperating ventilation equipment can be supplemented with a terrestrial collector, which sucks in the fresh air through an air intake pipe sunk into the ground. This pre-heats the fresh air in the winter and pre-cools it in the summer.

Another, simpler but less efficient version of air exchange is using air-intake units installed in the wall or window casements, attached to an internal exhaust ventilator. The air-intake unit, detecting the humidity level increasing along with the air becoming stale, automatically opens and then closes down when normal humidity is reached. In the course of renovation works carried out in the interest of energy-efficiency, it is essential to apply heat and humidity scaling; in the absence of such technical calibration, moulding, corrosion, illnesses and damage to the building can be expected.

In the case of low-energy or passive houses, the glazed doors and windows are no longer the sources of heat loss but rather the sources of heat gain, so it is often important to increase the glass surfaces on the sunlit fronts in order to maximal solar gains. The possibilities for this are the following: using south-oriented glazed surfaces and/or special glazing (mass wall, Trombe-wall, transparent heat insulation).

The cooling energy demand arises from the following components:
- warming of the building structures (transmission);
- solar load;
- ambient heat entering through air exchange;
- interior heat load (heat from inhabitants or users and machinery).

The cooling demand can be reduced by:
- increasing heat insulation (the warming time will be longer than the duration of the heat load);
- regulated air exchange and the instalment of passive heating;
- efficient sun protection and shading, including leafy trees and green fronts;
- increasing the heat storage capacities (heavy structures);
- reducing internal heat sources;
- night ventilation (free cooling).

In the case of residential houses, the above means are usually sufficient and there is no need for mechanical cooling.

7.2.2. Protection against the impact of warming

It is expected that climate change will directly result in a rise of peak summer and average temperatures within decades. Soon, peak temperatures of 40-45°C will not be infrequent, which will render certain types of buildings (offices, housing estates, light construction houses and lofts) unusable without cooling or heat protection interventions. According to Géza Molnár, there can be a difference of 10°C between the summer temperature of areas covered with forest and flat plains. The simplest extensive green roof is able to reduce the summer surface temperature by even 50°C (the temperature of solid paving or sheet metal surfaces is 80°C, while that of the surface of a green roof is 25 to 30°C). Consequently, the best climate regulatory device is vegetation and forest cover, which facilitates evaporation 8 times higher than that of surface of water. If air-conditioning is installed in each and every housing estate flat built using concrete panels, the street temperature may even rise by 10°C. The vegetation itself is able to perform the task of cooling just as well, as, according to G. Molnár's observations, air-conditioning equipment usually cools the internal temperature to 10°C lower than the outside temperature.

The process of desertification poses a double threat:
- the process of the land's desiccation,
- the decrease of humus in the topsoil.

The best protection against both dangers is increasing the proportion of green surfaces and helping the generation of humus, including through green architecture. Increasing the area of green surfaces is the most cost-efficient means of climate protection and, as such, belongs to the toolkit of local climate protection strategy. Green areas slow down precipitation run off, store it, and allow evaporation.

Developments in building energetics support, amongst other things, the spread of green technologies, the fulfilment of climate protection obligations, the creation of workplaces and the promotion of entrepreneurship. In the construction industry, a significant amount of the qualified labour force (not necessarily highly-qualified) is needed for energy-saving refurbishment and new constructions, which provides a great impetus for entrepreneurship in the creative and green industries (e.g. the application and distribution of high-performance construction products). The demand set by developments in building energetics improves the competitiveness of small and medium construction ventures and mobilises the designing, manufacturing, construction, trading, etc. capacities of the construction economy.

All in all, reducing buildings' energy consumption constitutes 'good practice' in the transition towards sustainable development, as it simultaneously decreases the dependence of countries on foreign energy sources, improves the economic situation of families and public institutions, encourages ventures, and helps us meet our international commitments and obligations undertaken in climate protection conventions.

The wide-scale application of climate-friendly solutions simultaneously serves the mitigation of climate change and adaptation to its inevitable consequences. Through proper heat insulation, sun protection and the proper orientation of buildings, their heating and cooling energy consumption can be considerably reduced. This results in a cut in greenhouse gas emissions and, consequently, in the mitigation of the climate change they cause. At the same time, the application of water-saving and semi-natural wastewater treatment technologies and the principles of green architecture also serve the adaptation to the changing environmental conditions.

Protection from the sun is generally achieved with fixed or mobile shading structures. The shading device can be placed on the external or internal side of the glazing or between the layers of the heat insulating glazing. As the glazing works as a sun trap, the shading devices absorb part of the incident solar radiation and warm up; furthermore, to ensure heat protection, structures are placed on the external side which can be ventilated and provide maximal summer sun protection. A traditional solution is fitting covered terraces and verandas to buildings so that their roof structures, making the most of the difference between the heights of the winter and summer sun in the sky, provide shade in the summer but let the sunrays enter the buildings in the winter, reducing this way the winter heating demand. Amongst passive houses there are, again, numerous buildings with verandas. Shading structures include transparent solar cells transmitting part of the incident light and producing electric energy at the same time.

If the demand for heating has been minimised by careful design but cannot be reduced any further, active cooling needs to be applied. In this case, three solutions are possible:
- the greatest comfort is provided by air-conditioning equipment which also treats the air; this entails the largest investment and operational costs;
- he investment and operational costs of air cooling (climate control) devices operating in the summer are also very high;
- the most cost-efficient solution is operating a heat pump with both heating and cooling functions in the building.

Some types of special glazing have in-built features, such as absorbent, reflexive and coated glasses; besides, there are ones with varying characteristics: the light-transmitting capacity of some glasses depends on environmental impacts (photo-sensitive, thermo-sensitive panels) or may be regulated by electricity. With the emergence of passive houses, the primary duty of glazing is to ensure maximum light transmission and winter heat gain. Therefore, instead of coating, efforts have been made for clarity and transparency and sun protection is solved by using special shading structures.

Figure 19: Passive house, Weiz, Austria

In buildings with large mass and heavy structures, the wall and floor structures absorb part of incident radiation, thus diminishing fluctuation in the room's air temperature. It also has to be mentioned that painting the external walls in white increases their albedo (ability to reflect light), as a consequence of which they absorb less radiation and warm up less than coloured walls. Similarly, the development of roof gardens, green roofs, double-shell cold roofs and attics has a heat insulating and climate regulating effect. The heat storing capacity is linearly proportionate to the mass of structures bordering the room. The impact of warming can be reduced in the simplest and cheapest way by good night ventilation, which cools off the bulky building structures with cool night air, significantly delaying reaching the maximum value of the inside daytime temperature. Excessive warming is further decreased by using a double-shell ventilated building cover on all the bordering structures.

Figure 20: Wind chimneys, Yazd, Iran

If the structures of a residential building are heat-technologically appropriate and its sun protection is solved, then there is no need for any cooling. This is primarily due to the fact that in the daytime most of the residential buildings are empty as the occupants work outside their homes or are in school, and apart from them there is no other heat source in the flat but the refrigerator. If they are at home, both the air exchange and fresh air cooling need to be solved. If the building has a proper heat storing mass, then, after having been cooled down during night-time ventilation (free cooling), the building can keep the lower temperature all day long, provided that the doors and windows are closed. Cooling incoming fresh air can be solved by passive, partly passive and active means:

– with earth collectors (fresh air is brought into the house through a pipeline laid in the earth which has a temperature of approx. 14˚C, hence cools without active cooling),
– with compact devices producing domestic hot water from the heat extracted from fresh air with heat pumps, as these devices provide cooled air for the living space,
– with passive ventilation systems such as wind chimneys, solar chimneys, or Venturi discs, which move the air without the aid of ventilators, leading it through cool places like cellars or shady yards with fountains, etc.

The simplest means of sun protection is planting deciduous trees in front of the sunlit front. This is followed by using veranda-type and other external shading structures. In addition to summer sun protection, the main goal is to maximise the winter solar gain, which can be achieved by designing fixed shading fittings similar to a veranda, or by using a mobile shading screen.

Even if a public building's sun protection is perfect and its structures are thermodynamically adequate, cooling demand is standard in terms of the buildings' energy consumption. This has two reasons:

- the persons present in the building, and
- the office equipment and lighting continuously produce heat.

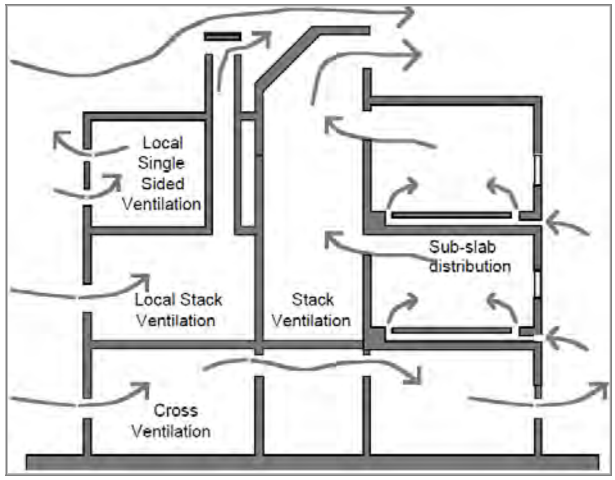


Figure 21: The Queen's Building, De Montfort University, Leicester (source: A. Zöld)

Heat produced this way comes in handy in winter because it diminishes heating demand to some extent. However, in summer this has to be removed from the building. It is possible to influence heat producing equipment (however, naturally, only the interior ones) in the following ways:

- with special architectural design which maximises both natural lighting and sun protection: proper depth of floor, atrium design, transparent partition walls, single-space offices, controllable shading or projecting lamellae;
- passive light units: skylights, photo-conductive channels (Velux, Solatube);
- selection of energy-saving office equipment: notebooks instead of desktop computers, LCD monitors instead of cathode-ray picture tubes, standby-killers which cut off the current for the night, separate server room with cooling or ventilation;
- energy-saving lighting, presence-detecting lighting, local lighting, light fixtures with LED's or compact light tubes.

It is important that the operator of the building can influence the selection of office equipment operated by the users.

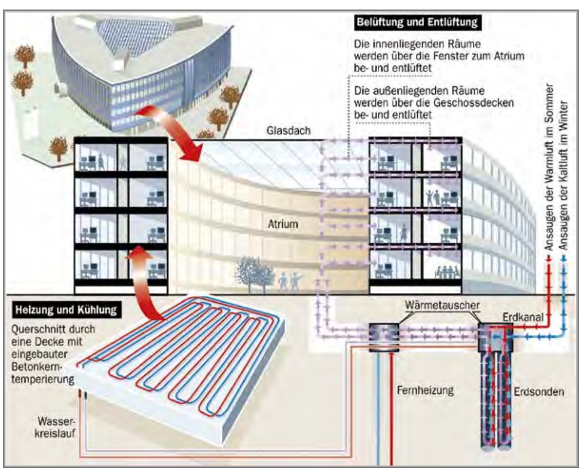


Figure 22: Ulm, Energon passive office building

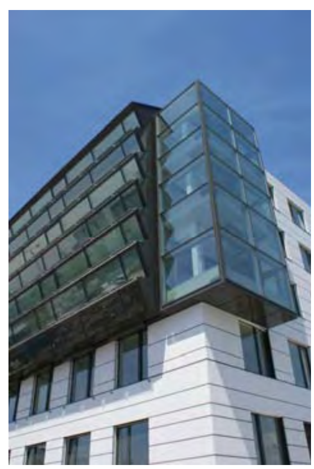


Figure 23: Vienna, Energy Base, passive office building (photograph: L. Szekér)

If we have already exhausted all options in terms of passive sun protection, the selection of proper building structures and the decrease of the internal heat load, then cooling demand has to be determined based on the remaining heat load. From among the active cooling devices, heat pump systems, which are also useable in winter for heating, are more economic than appliances only serving cooling. Those heat pump solutions which channel the heat withdrawn from the building into the earth or into the groundwater, using them as buffers, have outstandingly high effectiveness. Heat stored in the summer can be withdrawn from the earth in winter.

7.2.3. Buildings with almost zero energy consumption

Energy certificate, energy classes:

The European Union has introduced energy classes for buildings, too: a given building can be classified by preparing its energy certificate (green card). It is important to note that calculating the energy class not only takes the energy demand for heating into account but also the energy carrier used, effectiveness, and the heat needed for domestic hot water. Due to this, it cannot be considered as identical with the requirements of a passive house.

The EPBD does not define requirements related to 'buildings with nearly zero energy consumption' and leaves those up to the national authority. It is necessary to designate these categories clearly in the Energy-Efficiency Action Plan. There are a number of definitions and concepts circulating on this topic, which should be specified through professional consensus and included in legal regulations.

Passive houses (PH)

This is a concept elaborated by PHI (Passivhaus Institut, Darmstadt, Germany) and generally accepted, defining requirement values for the annual heating energy demand in respect of different types of buildings. In a basic situation, the requirement value is a heating energy demand of 15 kWh/m^{2}a for residential buildings, but the total primary energy demand of the building may not exceed the value of 120 kWh/m^{2}a. In comparison, the average annual heating energy consumption of Hungarian residential buildings is between 180 and 350 kWh/m^2. Passive houses also have heating but the heat demand for heating is so low that the necessary heating performance is some one-tenth of today's average: for a single home only 2-3 kW instead of approx. 18. Fewer heat-transfer appliances with smaller surfaces are needed. However, the ventilation system has to be part of 'active' engineering, because in the case of a perfectly insulated, air-tight building, the significance of heat loss during air exchange increases. The ventilation of a family house is operated merely by a ~60 W ventilator, the energy consumption of which is insignificant compared to the recuperated energy. The developed calibration software (Passivhaus Projektierungs Paket – PHPP) enables a more accurate calibration than that of the general, wide-spread software and, in addition to the engineering solutions, their primary energy demand also plays a role when evaluating the buildings. The PHI also offers solutions for passive house technology to reach this value (no thermal bridges, U values, air-tightness, heat-recuperating ventilation system) and has also elaborated and operates the qualification system for buildings and industrial construction products. The definition of passive house is acknowledged all over Europe. However, it needs to be localised, which also means aligning it with the more specific climatic features of the geography of the Carpathian Basin and consideration of the different requirements relating to residential houses and public buildings. For instance, besides a lower heating energy demand, the cooling requirements are of greater importance in Southern Europe than in Germany. (In Germany 'A^{++}' is ≤ 10 kWh/m^{2}a, passive houses.)

The EPBD still has not determined the requirements of cost-efficiency but the regulation's direction is clear. Passive house costs vary greatly. The first Hungarian passive house was built at a lower cost than the average price of a detached house built using traditional technology. But we can also find passive houses constructed at a price much higher than the aforesaid. According to the German data, the construction cost of a passive house is an average of 10% higher compared to traditional buildings. Several questions arise:

1. Can a passive house be constructed at the price of an average detached house?
2. Can the 'nearly zero' requirement be achieved with simpler technology and at a lower cost?
3. Can the passive house standard be made mandatory?

The answer to the first question is yes. Even if it can be difficult to implement the example mentioned above, the objective can be achieved with a light-construction building developed as a passive house and, in certain cases, and in certain cases, using even wet-process technology, too. The different types of light-construction passive houses eliminate the negative points that buildings with light structures usually have (e.g. the lack of heat storage capacity); in Austria most passive houses are built this way.

With solid walling, it is already more difficult to stay within the cost limits, but using local construction materials (adobe brick, straw) and with self-build, it is still possible.

The design of the house in the figure above was financed partly from a GIS (Green Investment Scheme) grant. The 125 m^2 residential house is independent of utility networks and operates with zero overhead charges for the price of an average residential house +8% extra expenses (www.autonomhaz.eu).

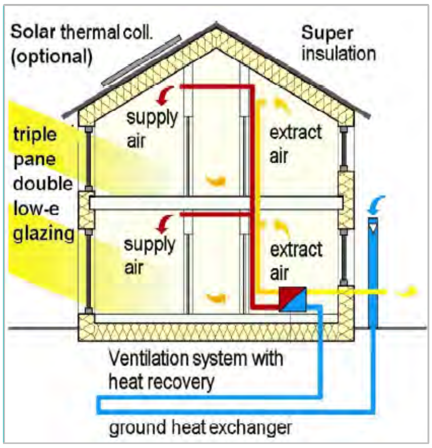


Figure 24: Principles of a passive house (Source: Passive House Institute)

To answer the second question: primary energy demand can be kept low by using locally produced renewable (solar and biomass) energy. So, in the case of a building with a lower heat-technology performance, this can be constructed more easily and cheaply than a passive house and the environmental load can be kept at nearly the same level.

Finally, answering the third question: making passive houses mandatory can be practical in the case of certain building types, but in the case of private construction, is by no means necessary. Passive houses, as a peak solution, must remain voluntary, similarly to active houses.

Both passive houses and low-energy houses can be constructed cost-efficiently and with nearly identical primary energy needs. With some further development, both of them are suitable for meeting the near zero requirement. The example shows well that producing domestic hot water with solar collectors significantly reduces the primary energy demand.

In the case of residential and public buildings, the renewable resources commonly utilised are mostly biomass, solar and terrestrial heat. The energy of the sun can be used for producing electric energy with so-called photovoltaic cells (otherwise known as solar cells) and for preparing domestic hot water with solar thermal collectors. These ancillary units can be placed on southern or south-western fronts or roofs.

Szada, the first certified passive house in Hungary

The passive house in Szada is a single-storey building with a floor space of 125 m^2 and no cellar. Its heating energy demand is 15 kWh/m^2 per annum. It has been built on a slab foundation, with polystyrene-framework, reinforced concrete technology.

Its hot water is produced by a vacuum-pipe collector and its heating is provided by a pellet boiler.

Its construction cost a gross sum of HUF 230,000/m^2a. With further development, installing photovoltaic units, the house is able to meet the requirements of a 'zero energy house'. The house was designed by László Szekér.

Växjö, a city quarter made of wood

Växjö lies in the southern part of Sweden and has approx. 56,000 inhabitants.

In 2006 the local government started to build a new district not far away from the city centre. The name of the 25-hectare quarter is Välle Broar and its speciality is that it is planned to construct the entire district from wood.

The objective of the construction is to demonstrate that it is possible to build from wood an environment that has a completely urban atmosphere and services of urban quality. As the country has an enormous stock of wood, obtaining the material is no problem. Due to its nature, wood is more environmentally-friendly than e.g. concrete, glass or plastics and is excellent also from a climatic perspective.

The project was started with three goals:
- increasing knowledge and raising interest related to wood construction,
- encouraging the use of wood, a material that can be used with less energy and a smaller ecological footprint,
- encourage customers to choose wood as a material providing a higher aesthetical experience.

Additionally, the new district will serve as the development site of the professionals of the University of Växjö, the city, local companies and research institutions. According to preliminary estimates, construction will take 10 years.

Contact:
Organisation: City of Växjö
Contact person: Peter Rydell
E-mail address: peter.rydell@vaxjo.se
Web: www.vaxjo.se/default.aspx?id=37078

Low-energy houses (LEH)

Originally of German origin (Niedrig Energie Haus – NEH), the definition of the low-energy house has spread from there all over Europe. In each country different requirement values of between 40 and 80 kWh/m^2a have been determined, including the heating energy demand. When establishing the requirements, it is an important to bear in mind that a value of 50 to 100 kWh/m^2a can be reached using traditional construction materials, with non-passive-house technology (the average value of contemporary buildings is around 350), and that the primary energy demand specified for passive houses can be easily achieved through their operation with local renewable energy resources. From a climate protection and cost-efficiency perspective, solutions equivalent to the passive house are also possible with this; therefore, it is not necessary to specify too strict values. It seems to be expedient to draw the line at energy class ‘A’ (for example, in Hungary ‘A’ ranges from 55 to 75 kWh/m^2a, in Germany, due to the different calculating method ‘B’ is ≤ 50 kWh/m^2a, ‘A’ is ≤ 25 kWh/m^2a, and ‘A^+’ is ≤ 15 kWh/m^2a, both called ‘Lowest Energy House’).

For the construction of ‘nearly zero’ buildings specified by the EPBD, an essential, primary condition is that the new buildings satisfy at least the requirements of the Low-energy Houses or energy class A or A^+. The next priority is that the energy supply of these buildings can be met with locally produced renewable energy and low primary-energy demand. This requires the development of local, decentralised, communal energy producing systems.

Energetically self-sufficient houses, autonomous houses (AUH), active houses:

The concept of ‘zero’, i.e. energetically self-sufficient, active or Zero-energy houses surpasses the definition of ‘nearly zero’ houses. The nearly zero requirement is best covered by the concept of the **Autonomous house**, which means independence from energy needs. To meet all these requirements it is essential to extend the requirements to the field of electric energy consumption. The literal interpretation of the strictly 'zero' category excludes biomass heating, as it is necessary to input a renewable external energy carrier (biomass). This renders individual self-sufficiency impossible and only facilitates heat-pump solutions operating based on electricity. This, obviously, cannot be an exclusive requirement, as there is an enormous potential available in CO_2-neutral biomass fuel. Therefore, rather than **self-sufficiency,** the concept of **independence (autonomy)** can be set as a requirement for the objective of building-energetics, local energy strategy, as well as national energy strategy. This requirement facilitates co-operation between areas with different characteristics (residential blocks, city quarters, cities and their outskirts, microregions and even cross-border regions), where the actors can supplement each other's surpluses and shortages. Self-sufficiency, such as isolated network operations, requires the construction of unnecessary storage and reserve capacities, which can otherwise be replaced by a multi-sourced, network system.

A settlement's climate protection strategy has to include a system of requirements for new building stock and the tasks required to upgrade the existing buildings. In the case of new construction, the requirements of EPBD prevail; therefore, houses with at least lower energy demand (AEH or Class A) need to be constructed. In the case of a building worse than this, the aforesaid objective cannot be achieved in a cost-efficient manner. The passive house technology is particularly suitable for public buildings, e.g. schools, where there are many people staying in one room, e.g. in the class room, and fresh-air supply has a great significance. In school time this is over 90% effective, which is reached by minimising heat loss and using heat recuperating ventilation equipment; this is made possible by the heat released by the children, which warms the building.

Dresden-Loschwitz Passive school,

The Friedrich Schiller elementary school in Dresden. 171 children study here. The building has 2,777 m^2 useful floor space and a heating demand of 80 kW. Heating only operates when there are no students in the building. In school time the students' body heat warms the building. The new school building was built in 2008-2010.

Contact:
Architekturbüro Raum und Bau GmbH
Telephon: +49 351 8412250
Telefax: +49 351 8412252
E-mail: post.dd@raumundbau.de
Web: www.raumundbau.com/e14/e4053/index_ger.html

The existing stock of buildings have the highest saving potential if energetically upgraded to the highest degree, so this has to be given a particular role in the strategy.

Active houses

The definition of **Active house** is rather a 'PR concept' used to highlight the difference from passive houses. Accordingly, active houses are energetically self-sufficient buildings, which, as per the definition, produce more energy than they consume. These buildings mostly have heat-pump heating operating with electricity produced by their own photovoltaic (PV) surfaces, where extra production only occurs seasonally, i.e. in summer. In winter, active houses produce less energy than they consume and they buy energy to cover this shortage from the income originating from the electricity they sold in the summer. Taken on an annual average, there is a zero cost balance between the surplus energy produced and sold, against the shortfall purchased. Here we are speaking of an energetically autonomous building which presumes a high-capacity electric grid. If too many such houses are built, this shifts the energy used for heating towards electricity and this may cause national problems and CO_2 emissions may increase more. This risk does not exist, for example, in Austria as it has significant hydroelectric potential. However, the number of heat-pump systems can only be successfully increased in countries like Hungary if these systems are capable of utilising night-time electricity. This requires a more subtle regulation of the heat-pump systems.

Producing more electricity than required for sufficiency is possible but not profitable as producing electricity in a decentralised manner and on a small scale (by the help of solar and wind energy) is very investment-intensive. What is the traditional definition of a facility producing more energy than is required for its own consumption? A power plant. Producing electricity on the scale of a power plant is far more efficient and cheaper than this, even when speaking of a local, decentralised, small power plant (e.g. biogas-based combined heat and power production, or wind-power plant). It is a challenging enough requirement for a building to achieve autonomous and independent operation, meeting its own electricity demand, even with biomass heating.

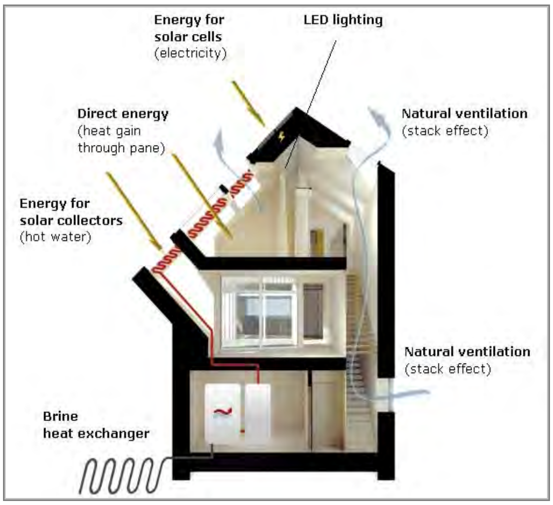


Figure 25: Sunlighthouse active house, Austria

Figure 26: Autonomous rest house at the Monte Rosa, Switzerland

***Zero CO_2, Zero carbon, or Climate-neutral buildings**:*
Given the lack of a precise definition, there is a wide room for interpretation due to the fact that the building itself does not emit any CO_2 or its primary energy consumption is also free of CO_2. In certain cases, specifying total CO_2-neutrality means a requirement level exceeding even that of a passive house, which can, at the very most, be conceived as a long-term objective.

***Water-efficiency**:*
Climate change requires that drinking water be better appreciated. Drinking water resources are finite and the price of water, too, will keep increasing. These expenses may exceed the annual heating costs of an apartment. Consequently, in addition to the unarguably crucial energy-efficiency, it is also essential to favour water-efficient solutions; these can reduce costs by 50 to 80 %. In their absence, the practice of illegal wastewater disposal will become more widespread. In climate control, an important role is played by the local treatment and recycling of wastewater and water-saving solutions, including the utilisation of rainwater, which collectively decreases the burden on water stocks. From among the decentralised treatment technologies, phytoremediation plays an important role in evaporation, in carbon sequestration and in oxygen production. Technologies without any protective distance, e.g. the Kickuth reedbed technology, can even be applied within the cities (Berlin-Kreuzberg, Block 6).

7.3. ADAPTATION TO AND PREPARATION FOR CLIMATE CHANGE IN THE CONSTRUCTION INDUSTRY

According to estimates, one of climate change's most significant effects is the expected increase in the occurrence of extreme weather events. These events may be, for example: heat waves, early and late frosts, heavy rains, storms, and as a consequence, floods and excess inland water, and at the same time extended dry periods, severe droughts, and strong windstorms.

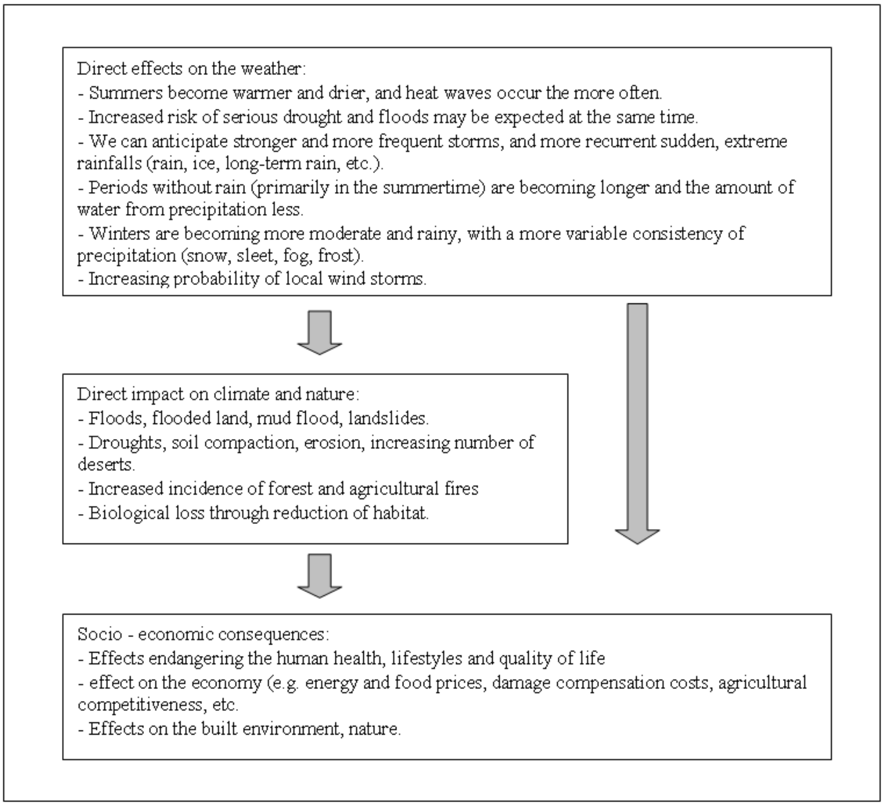


Chart 1: Direct and indirect climate effects, complex social consequences

In many cases, the majority of local climate changing events are caused by human activity. From among the factors influencing the micro-climate, the most important is the proportion of forest areas and open plains, the proportion of green areas and paved surfaces. Increased aridity and its opposite, excess inland water are general phenomena due to the regulation and diversion of natural water courses, drainage and other factors. Clear-cutting forests also affects the mesoclimate, and as a consequence, the area receives less rain. These human interventions disturb the balance of surface and underground waters.

When developing the built environment - with the exception of the areas in the Mediterranean - today only a little attention is paid to climate change, despite the fact that summer heat waves affect people’s home comfort. When designing the buildings, both the inhabitants and the construction industry focus primarily on the decrease of winter heat loss. Generally, besides insulation, greater emphasis should be laid on sun protection and the buildings’ thermal comfort.

Another deficiency needing taken into consideration in building design, is the fact that summer rains are becoming less frequent. The expected increase in maximum wind speeds is another factor not receiving adequate attention in current building practices. Construction regulations relating to roofs and facades do not provide sufficient specification, therefore, the increase in wind speeds will also cause a major problem in the case of both existing and new buildings.

A critical problem for construction is that in the future, building sites and activities are expected to become increasingly weather-sensitive. During external construction, activities performed in the summertime may carry an increased work-security risk due to the high temperature and an increase in UV radiation. The conditions for concreting operations are becoming more and more difficult; as a consequence of dryer and warmer summers, the time required for hardening is affected. Roof-building work also becomes harder to carry out on hot surfaces (steel roofs).

7.3.1. Adaptation to heat waves, extreme weather events and storms

In southern Europe countries, summer heat waves are common seasonal events; however, in the future they are expected to become more frequent in the northern areas of Europe, too. The fore-mentioned architectural solutions for adaptation make the use of energy dependent air-conditioning redundant.

The expected increase in the intensity of maximum **wind gusts** due to climate change affect primarily the structures on the buildings' exterior, those constructed on façades and roofs. Besides concerns about the supporting structure, problems can primarily be expected with windows, shading, and façade decoration. On the roof, damage is most likely to occur to the roofing material and water-proofing, furthermore, to objects projecting from the roof such as lightning rods, chimneys and antennas. Strong winds occurring around the buildings may also damage road-side infrastructure and objects (traffic lights, electricity pylons, phone booths), and trees as well, potentially causing serious damage to the buildings.

In order to prepare for the increased frequency of big storms, city authorities have to make appropriate calculations and measure how resistant the buildings are against such events.

Tatabánya, effects of climate change on the building stock

One possible method for assessing the estimated effects of climate change has been prepared by the research project CLAVIER (Climate Change and Variability: Impact on Central and Eastern Europe). The buildings of a Hungarian middle-sized city, Tatabánya were evaluated taking into consideration the effects climate change predicted for 2021-2050 may have on the wind-resistance of roof structures. However, the methodology may be effectively applied in the case of any city. The first step of the evaluation is to put the buildings into different categories, following which the vulnerability of these building types is assessed in terms of their exposure, sensitivity and their ability to adapt.

The level of exposure, i.e. the degree to which buildings potentially suffer from storm damage depends on the basic wind load; when calculating this, the two most significant factors have to be included: the height of the building, that is, its roof, and the building density of the neighbourhood. The **sensitivity** against wind storms depends primarily on the construction of the roof, its size and type of cover (roof covering with small or large panels), as well as other buildings and trees in the closer proximity of roofs. Regarding the performance of the main structure, the age of the building is one of the most significant factors, because the time of construction determines what kind of standards and regulations were applied by the designers and the architects.

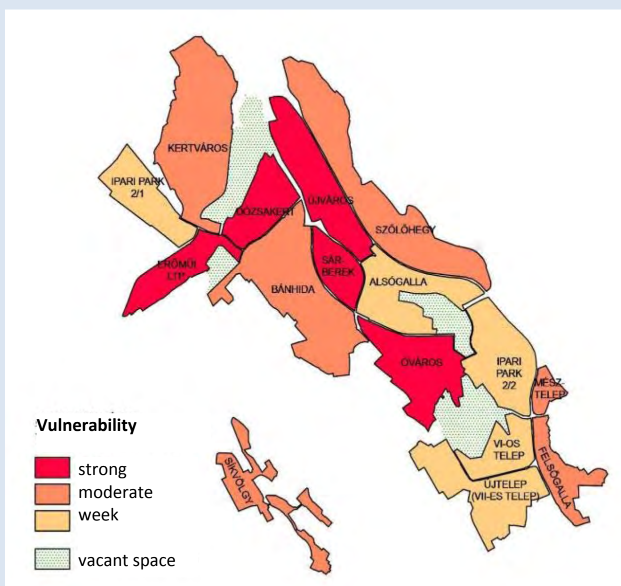


Figure 27: The wind-vulnerability of the buildings in Tatabánya

Finally, when assessing the **ability to adapt,** the social circumstances of the residents and users of the buildings, as well as their attitudes and financial possibilities had to be investigated in the areas studied. Having defined the level of exposure, the sensitivity, and the adaptation ability of the different building types, their complex vulnerability was calculated by means of a simple algorithm.

The results were summed up in a map, based on which it is understood that almost 25% of the citizens of Tatabánya, live and work in the most vulnerable building types in terms of wind hazards.

Source: D. Jacob, A. Horányi, L. Li, A. Gobiet, S. Pfeifer, G. Bálint, T. Pálvölgyi, and F. Prettenthaler (2008): Climate Change and Variability: Impact on Central and Eastern Europe. THE EGGS (EGS Newsletter) ISSUE 25 October 2008, 22-26

Having thus evaluated the vulnerability of buildings to wind hazards, the results can help identify those buildings and building types with roof structures that need to be urgently reinforced. In addition to outlining the immediate protection tasks for the current situation, the most effective wind-protective measures for the future are the planting of forest shelter belts and the creation of green surfaces in terraced structures. In the case of forestation, mixed forests and deciduous species have a stronger resistance against wind storms than spruce.

7.3.2. Flood-proof construction

Generally, extremely heavy rainfalls occur unexpectedly, and hence they can only be forecast a few hours in advance. Topography, plant cover of the area, the condition and capacity of the water drainage systems, the structure and location of the settlements may all have an influence how much damage occurs. These excessive rainfalls have increased flood hazards in Hungary, too, where an increased occurrence of excess inland water is anticipated in lowland areas. Sudden rains can also induce landslides in certain regions, which can cause serious financial damage, and there is also likely to be an increase in damage to buildings, caused by swelling clay.

As a consequence of sudden massive rainfalls, water drainage is gaining in importance in the life of a settlement (rain collecting drainage network) and for the safety of individual buildings (drainage canals, sinks). Due to the increased amount of rain, these may easily become overloaded. Chapter 8 provides more details regarding the tasks of water management in preparation of the communal urban infrastructure for extreme weather situations.

In order to avoid future financial losses caused by floods, it is imperative to revise **construction regulations** and make them stricter, as well as to obey them in a consistent way. Among these regulations, the most important is to introduce a construction ban in the areas under direct threat by floods, and also, to identify the areas that are potentially endangered by subsidence (high banks and loess walls). Measures are needed to avoid socio-economically disadvantaged groups settling (even illegally) in areas at risk of flood, excess inland water, and subsidence. Nevertheless, in regulating flood protection, it is necessary to judge rationally the balance between the value protected and the costs of protection.

7.3.3. Preparing the existing building stock for water scarcity

Water is a valuable resource. After energy, drinking water and fertile soil are the two most important strategic resources. The protection of water reserves goes far beyond environmental protection, impacting other issues. In today's world, local wars break out partly over the possession of water. There are still some opportunities to fight further desertification, one consequence of which is the depletion of soil and its humus content. We have to design land use that contributes to humus formation, starting from the smallest scale (households, small gardens, green roofs) to the largest ones (agricultural development). For this, integrated water management strategy is needed, where regional water resources are treated as a system in order to be able to recreate the balance between surface and ground waters.

To help the adaptation of settlements to climate change, the reduction of water consumption by the residents and the introduction of water saving practices are among the most important policy areas.

Their significance may be compared to energy saving and the importance of cutting GHG emission from transport. Besides the technical solutions, conversion and regulation of consumer behaviour also play a crucial role. Although climate change dictates a more considered, resource-light, pattern of individual water consumption, this also needs to be realised in regions with ample water supplies.

Amongst the non-technical solutions, one possible option is the regulation of the **price of water**. Experience shows that there is a clear connection between the increase in the price of water and the decrease in water consumption. Nonetheless, there is a need to assess the application of this and the degree of its application from various perspectives. In an urban environment, where there is no alternative way of obtaining water, it may be really effective. However, in the countryside and in areas with detached houses, it may increase the amount of illegal water extraction and prove contra-productive. Privately-owned water works can (ab)use the argument of 'higher prices = more water savin' in order to support the idea of water privatization and to justify otherwise unreasonable price increases, against the interests of local municipalities. This reasoning flies in the face of the main aim of saving water, that is, to make this resource accessible for everybody over the long term – which is almost impossible on a market basis.

Figure 28: Schematic structure of a domestic rainwater harvesting system

Water is a renewable natural resource and therefore, it cannot be privatised. In water provision, there is a possibility for the emergence of private entrepreneurs if it does not result in distortions in the access to water. The user of water reserves (whether it is a service provider or a private person drilling a well) has to be obliged to pay compensation for the use of water. Drilling wells has to remain an activity needing a license because water resources are not infinite.

The **installation of individual water meters** and the termination of flat-rate water fees are two of the most effective solutions. In flats in prefabricated housing blocks, before the installation of individual water meters, consumption reached 400 l/person, and following the installation of the meters it immediately fell to half of this (200 l) (A. Ertsey, G. Helyes, 1994). The desired average urban consumption is around 150 l/ person. This may be reduced to 70 l/ person by making the most of water-saving opportunities.

The most important technical solution is to **use water conservation devices, taps and bathroom equipment**. Most household appliances, such as washing machines and dishwashers, garden watering systems and multi-sink kitchen basins may be purchased equipped with low-flow water devices, and the producers, understandably, support their use. It is mainly financial limitations that restrict customers' choices. However, the installation of certain more expensive devices may be substituted simply by more careful water consumption.

It is possible to reduce water consumption by even 10-20% with the help of low-flow taps and other equipment. Water and energy saving dishwashers consume less of these resources than doing the washing up by hand (1 litre/place setting), although their price is still relatively high and the investment-return time is between 10-15 years. In the case of washing machines, the saving can be greater: investment in a top-quality machine is paid back in less than 10 years. Water-efficient toilets make it possible to flush the toilets in two phases. Should the building be connected to a traditional drainage system, the longer flush must not be less than 4.5 litre/flush, because using less water than this is not sufficient to transport solid dirt and may cause blockage. If the toilet flushes 4.5 litre, it is necessary to install a flushing siphon into the outlet pipe, because this collects a safe amount of water and flushes at once, safely forwarding the sewage to the street canal.

Domestic rainwater harvesting in Europe has gone out of fashion in the times of abundant water supply, although rainwater collecting cisterns were still part of the basic infrastructure of holiday homes and press houses in Central Europe, in the first half of the last century. Collecting rainwater is becoming popular in Germany and in Austria. Nowadays, suitable filtering and storage devices are available on the market, designed for home-assembly. Provided with proper filters, they may also be installed in densely built, urban areas. In the case of a house with a garden, 20% of a family's water consumption may be met from an annual precipitation of 500-600 mm, naturally with the exception of bathing and drinking water. This has further advantages, such as reducing the burden on the drainage system. Using soft rainwater in the washing machines is also advantageous: less washing powder is needed, and scaling will stop.

Recycling **grey wastewater** (greywater) also offers a good opportunity for conserving water. There is equipment available on the market which cleans from 1.5 m^3 of greywater for re-use in the washing machine. A theoretical solution has long existed but has not yet been mass produced in commercial quantities; home-made, DIY versions, of a device that allows greywater to be diverted for the purpose of flushing the toilet. All that is needed is a 200 l tank, a washing machine pump and some ancillary equipment. Solutions able to handle larger amounts of water efficiently offer a transition towards whole-house sewage recycling. In the desert areas of Australia and the US, greywater recycling systems are operated in public buildings. Greywater recycling can substitute 40% of water consumption. Using rainwater and greywater together may reach 60%, hence conserving drinking-quality water; this may be increased to 70% if water conserving devices are also installed.

Some types of the **dry toilets** available for the home do not dilute the bodily wastes but dry it and mix it with additional material. The small amount of odourless material has to be emptied from time by time into a garden compost prism, or silo, where it continues to compost.

Compost toilets mix faeces with additional material containing cellulose (wood chips), organic waste from kitchen and a small amount of material containing soil bacteria (soil, compost). Proper ventilation, temperature and oxygen supply are ensured, so that natural hot composting can start. During composting, the organic waste is reduced to one-quarter of its volume and becomes odourless, sterile humus. Certain types of compost toilets have outlet pipes long enough to run between floors, which solves composting in a single container in two-storey houses. One type is able to manage waste from 8 toilets on a single line. In this case water-efficient toilets are required. When these toilets are flushed, sewage flows into a device for removing fluid, similar to a spin dryer, which forwards the solid content to the compost chamber and the liquid part flows into the drain.

Compost toilets save approximately 1/3 of the drinking water consumption, but their real significance is in reducing the amount of sewage and in creating humus. Their application is positive both in areas with and without a public sewage system. In the later case, they facilitate a simpler cleaning of the sewage, since the most contaminating part is eliminated from the water. They reduce the amount of sewage emission by ~ 30%, and improve its quality.

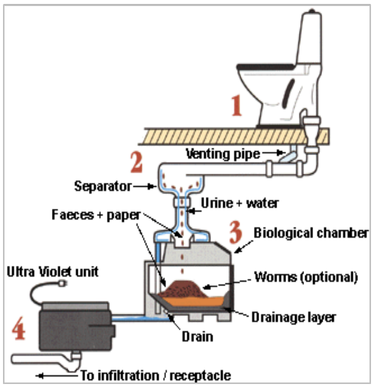


Figure 29: Compost toilet and its schematic structure

Domestic sewage management systems treat the entire amount of sewage, grey- and blackwater, together. As well as compact equipment, we also have to mention the semi-natural cleaning technologies which use plants and soil bacteria for purification, without using machines or energy (reedbed technology). Where soil is able absorb, simple filtration basins or tanks are able to treat sewage, too: sewage is first diluted into a thinner solution and then its purification is completed on the filtration site, in the soil. These solutions also conserve root-level irrigation water, and help the restoration of ground water.

In contrast to properly operated, simple or extended septic tanks, there are (formerly wide-spread) cesspits which have to be closed; sewage from these passes undiluted, directly into the ground, and into the ground water. Even more dangerous are those mandatory sewage containers which were constructed as 'closed' but were subsequently illegally punctured; contaminated solids from these pass straight into the ground. It would be more advisable for planning authorities to permit the use of simple cleaning technologies and make closed storage facilities mandatory in exceptionally sensitive areas, as well as strictly monitoring the volumes of transported sewage.

Over-rigorous requirements sabotage correct behaviour, causing more serious damage than less efficient cleaning technology. If somebody constructs a single treatment system on his own land, it is in his own interest to avoid using materials that go into the sewage water and harm the environment (e.g. chemicals, used oil, etc.), since these would damage his own garden. By using environmentally-friendly washing and cleaning substances, both of the above situations can be prevented.

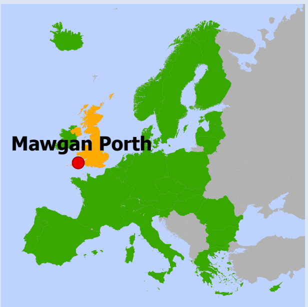
The use of **green roofs** also contributes to the implementation of sustainable water management. One of the first steps in sustainable water management is retaining rainwater with the help of green roofs. These have a beneficial effect on noise levels and heat insulation, and impede the creation of urban heat islands. Since the utilisation of green roofs depends primarily on the construction of the buildings, their implementation is an element of sustainable construction. When installing a roof with vegetation on it, the selection of plant species and planning irrigation are serious tasks. Extensive green roofs carry drought-tolerant plants which can generally do without irrigation, while the intensive green roofs need a continuous water supply. However, the idea of frequent irrigation is contrary to the reason for creating green roofs. This needs to be avoided because it consumes a significant amount of energy and water. The creation and maintenance costs make it uneconomical, although, of course, having a raised bed on our terrace may provide a welcome supplement to home cooking.

Figure 30: Reedbed sewage treatment in Vácrátót, Hungary

With the latest generation of extensive green roofs (with a total layer depth of 6-15 cm, and with a relatively low weight of approximately 60 kg/m^2), it is possible to utilise this technology extremely quickly on any roof which has a slope of less than 45°. The green roof protects the roof as well, extending its durability.

The summer 'canyon climate' phenomenon is a particularly unpleasant experience in traditional Southern-European cities. The high surface temperature on flat roofs create hot air above the city, while the slightly colder air is locked into the narrow, shady streets, where, mixed with the exhaust gas, creates smog. This problem may be alleviated by green roofs and wider streets that can facilitate ventilation.

However, although some sustainable construction solutions can substantially contribute to the reduction of water consumption in an indirect way, through carefully planning and building our gardens, we can reduce their water demand; by fitting our house with a dual water system (drinking water and rainwater) and drainage (grey- and blackwater), we can choose to utilise rainwater as well as recycling greywater.



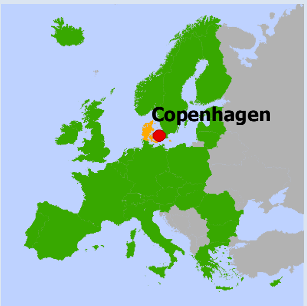
Scarlet Hotel, complex sustainable architectural solutions

Mawgan Porth is a popular holiday resort in the North of Cornwall, Great Britain, and is home to the recreation centre, 'Scarlet Hotel'. The 37-bedroom hotel was opened in the summer of 2009, and is special in that the architects aim was to create a hotel that provided comparable services with less and cleaner energy; sustainability was to be achieved at the highest possible level.

Sustainable construction and operation are served by the following solutions. Parts of the roofs were built using green roof technology, slowing down the flow of water. Special attention was paid to insulation, the use of alternative energy resources (e.g. via solar collectors), ventilation (7% passive, 85% with heat recovery). Rainwater and recycled greywater are both utilised: the former is used to fill a swimming pool (in which natural vegetation was planted to clean the water in an organic way); the latter is used for flushing the toilets. Firewood obtained from sustainably managed sources is used to heat water. Recycled and recyclable materials are widely used as part of the structure and interior equipment.

The building has a wooden structure, and the materials used are certified by the FSC (Forest Stewardship Council). The product chain certification of the FSC manages the timber through processing and trade, from the forest to the final consumer. Also, when building this hotel, concrete containing less cement was used. To further reduce its ecological footprint, the hotel offers an additional route planning service for both guests and staff.

Contact: Suzie Newham
E-mail: snewham@bedruthan.com
Telephone: 01637 861203
Web: www.scarlethotel.co.uk



Copenhagen, Green roofs

The Danish capital of Copenhagen is the most important economic center in the Øresund region and, with 1,167,569 inhabitants, is the largest city in Scandinavia. The 'Green Roofs in Copenhagen' project was launched in 2008, and was initially only connected to sewage treatment plans and local rainwater management. Its main aim is to cover the roofs with vegetation, making a significant contribution to the city's adaptation to climate change. In order to be achieve the greatest success it was necessary to extend the use of green roof technology, for which the most effective method is regulation.

Discussion started on the use of green roofs at the 15th UN Conference on Climate Change (COP 15), in Denmark. As the conference's host, Copenhagen took the opportunity to suggest green roof technology as a possible solution to the challenges of climate change. Consequently, Copenhagen successfully inserted a paragraph about green roofs into the Climate Plan, emphasising the connection between green roofs and rainwater management and arguing that an increase in rainfall can be expected in the near future. Importantly, this measure also aids the creation of an even greener city and helps tackle the urban heat island phenomenon. The green roof implementation period was clearly defined in the Climate Plan, and was also prescribed as a requirement in the Urban Development Plan.

In the last few years several initiatives similar to the green roofs were undertaken by the city:

- Urban Development Plan,
- Climate Plan,

- local plans,
- handbook on the creation of buildings' environment,
- sustainable measures,
- Green Roof Policy.

Green Roofs policy in Municipal plan 2012
In Copenhagen it will soon be compulsory to cover the roof of every newly constructed flat with a green roof. It is stipulated that every roof with a slope of less than 30 degrees has to be covered with greenery, both in the case of private and public buildings. Where an older roof needs converted and the owner of the building receives financial assistance for this from the city, it is compulsory to make it 'greener' (cover it with trees, bushes, moss, herbs and grass).

The institutional network plays a remarkable role in popularising green roofs. At the local level, the role of communities, independent environmental organisations and administrative institutions is the most crucial. At the national level, the co-operation between various universities and other institutions is indispensable, ensuring knowledge, technology and consultation, and disseminating technological and market-based innovation. Finally, at the international level, a key role is played by the international green roof associations, e.g. IGRA, GRHC, Living Roof, and the universities cooperating with these bodies.

Contact:
Dorthe Rømø Project manager,
City of Copenhagen,
Technical and Environmental Administration,
Parks and Nature Department
Telephone: +45 3366 5843
E-mail: dorrom@tmf.kk.dk
Web: www.kk.dk/groennetage

7.3.4. Heritage conservation

The effect of climate change on monuments is a key concern, not only because of tourism but also because of the need to preserve cultural heritage and its role in maintaining national identity. Therefore, eliminating the negative effects of climate change on urban heritage also constitutes a significant task.

The problem is not significantly different from architectural solutions for non-monumental buildings, although the modern building materials and construction methods used for newer buildings may prove more resistant to **environmental damage caused by climate change**. The walls of the buildings become porous after coming into contact with the chemicals dissolved in rainwater, they start to crumble and their structures become weaker. The increasing frequency of heavy rainfall may also cause considerable damage, as drainage systems are not able to bear the sudden, large amounts of run-off. Air-carried pollutants deposited on the building's surface can also have a harmful effect. The extreme fluctuation in daily and yearly temperatures also takes its toll. Changes in temperature and humidity cause cracks and splitting. In the moderate climate zone, the frequent shifts between freezing and melting also cause serious damage to the structures. The ever more extreme weather events such as storms, hail, lightning, etc., do not spare monuments either. In the summer of 2010, a number of Hungarian monuments suffered significant damage from storms: The Károlyi Castle in Füzérradvány, the Esterházy Castle in Fertőd and the L'Huillier-Coburg Castle in Edelény, as well as the buildings of Ménesbirtok in Mezőhegyes, the Dégenfeld Castle in Téglás.

Pests pose a danger to the wooden and other organic building components of monuments. The growth in their numbers, their spread, as well as the emergence of invasive pest species new to a given area has become quicker; their habitats have expanded, presumably as a result of climate change. Mould and insects which cause rot can cause substantial damage to organic construction materials, particularly if these historical buildings or monuments are out of use, there is no ventilation and the roof is leaking.

Floods affecting places of important national heritage can also cause significant destruction to monuments, especially in areas that were previously less threatened by floods; here the buildings' foundations and general construction were not planned to resist flood water. Floods have become increasingly frequent as a consequence of certain changes in human activity, such as deforestation and regulation of rivers, which change the water balance. Drying climatic conditions may also influence the structure of building materials; furthermore, an increasingly moist environment may also favour the spread of mould. Among recent floods, those during 2002 were especially notable; covering almost the whole of Central Europe, the downtown areas of Dresden, Prague, České Budějovice and Český Krumlov went under water, causing serious damage to monuments as well. In Hungary, due to heavy rainfall in the Spring of 2010, an important part of the Tokaj World Heritage Site, the Hercegkút cellars, were flooded and collapsed.

The erosion of river banks, sea coasts and lakesides leads to the modification of riverbanks and coastlines, posing a danger to the monuments found there. The rising sea-level and sinking coastline cause downtown Venice to be more frequently immersed. The increasing occurrence of land collapsing along river banks, subsidence and landslides (mass movements) rarely affects monuments, but when it does, it causes serious, irreparable damage. In July, 2010, in Abaújvár in Borsod-Abaúj-Zemplén county, Hungary, heavy rain caused a landslide that endangered the town's gothic church and caused several walls of the historical, Abaúj motte to collapse.

In many cases human activity has led to the increased vulnerability of cultural heritage. Alterations in the immediate natural environment (e.g. the reduction of green areas by increasing amount of constructed surfaces, changes in water run-off, indirect effects of increased tourism, the emergence of wind channels in cities, vibrations due to heavy traffic) as well as more indirect anthropogenic influences (e.g. deforestation in the water catchment area, changing groundwater level) may also increase monuments' vulnerability.

Historical gardens or parks form part of our cultural heritage. In many of these, small ponds were established which are fed from groundwater or streams. Neglecting these lakes adversely affected the groundwater balance in many places, as well as the microclimate of the garden, changing the composition of the vegetation. Almost all historic buildings (particularly in urban areas) have wells, which are often closed but they have an effect, even when covered, as they increase the moisture content in walls.

When **renovating** historical buildings or monuments, modern technological solutions which help adaptation to the adverse effects of climate change cannot usually be applied, or incur high costs. This is either because of the structural characteristics of the existing buildings or because the historical streetscape or vista is protected. Together, these make adaptation to the consequences of climate change all the more difficult. In historic gardens and parks, the landscape solutions that were once able to limit the negative environmental impacts should be restored. The use of authentic materials and techniques should also be considered in certain cases. The elimination of damage caused by air pollution and the harmful effects of natural processes are significant problems. Climate change negatively impacts the conservation of ruins, particularly through damage caused by subsidence, rapid temperature changes and frost. In these cases, efforts should be made to reconstruct authentic roof structures.

Archaeological sites and graves will also suffer significant damage due to climate change. A number of international initiatives have been launched at World Heritage Sites to mitigate the impacts of climate change and reduce its root causes.

Český Krumlov, monument protection after flood

Lying on the banks of the River Vltava, this small town has almost 14,000 inhabitants. The town was built around a 13th century castle and is home to gothic, renaissance and baroque monuments. Throughout history, it was lucky to avoid wars and bigger catastrophes and hence remained quite unique in Central Europe, having retained most of its original form. Thanks to this, in 1992 the historical downtown area of Český Krumlov was nominated by UNESCO as part of the World Heritage.

In August 2002, half of the monumental buildings and almost 150 gothic and renaissance constructions were flooded in the historical town. The water rose to 4 meters in some places and flooded the ground floors of the buildings. The city suffered damage estimated at almost 300 million Czech crowns, despite the fact that instead of wood and adobe, which were widespread in contemporary times, the builders used more resistant construction materials (brick, lime), which saved the city from even greater destruction.

After the water receded (September 2002), the most urgent task was drying out the wet walls before the winter freeze, which could have caused further serious damage to the buildings. Restoration and the prevention of further destruction by floods were made more difficult by the fact that the use of more up-to-date, resistant building materials was not allowed as due to the conservation order.

Extreme precipitation events are becoming more common due to climate change, a phenomenon that can be both observed and measured. Therefore, the Czech government has initiated the preparation of an action plan against floods in World Heritage Sites.

Further information:
Web: www.ckrumlov.info
Photo: www.czechproperty.blogspot.com

BRIEF RECOMMENDATIONS

- Reduction of existing buildings' energy consumption.
- Application of innovations in energy-efficient construction (e.g. passive house).
- Implement developments in construction energetics (e.g. energy-conserving renovation; use of climate-friendly solutions in construction).
- Analysis of the entire life cycle of buildings.
- Minimisation of energy consumption for heating.
- Support the use of renewable energy (solar and geothermal) for supplying domestic hot water.
- Pay attention to adaptation to the impacts of climate change in the building industry and the development of design solutions for heat waves, extreme weather conditions, and storms; utilise flood-proof construction.
- Preparation of buildings for extreme weather conditions or water-scarcity.
- Review building codes and regulations to support climate change mitigation and adaptation solutions.

8. ADAPTABLE WATER MANAGEMENT AND URBAN COMMUNAL INFRASTRUCTURE

The potential contribution of water management, drinking water supply, wastewater treatment and waste management to the reduction of greenhouse gas emissions is relatively smaller. In urbanised regions, however, it is still worth dealing with these smaller-scale emissions because settlements may this way show good example to the private sector and the consumers. Apart from this, the reduction of emissions also contributes to energy saving and economical operation; therefore, the mitigation of climate change may require some developments which are useful and necessary in other ways, too. Emissions are mainly indirect; greenhouse gases are released from the production of the energy in power plants that is needed to operate the infrastructure or by transportation vehicles. Mitigation primarily affects waste management, which is the prime direct greenhouse gas emitter of the communal infrastructure; however its share in emissions is still substantially lower than those of transportation or energy production. Methane and carbon dioxide is released from the anaerobic decomposition of organic materials in landfills and from composting plants, and optimally, only carbon dioxide is emitted from incineration plants. When it comes to wastewaters, some methane is emitted, generally in smaller amounts, the source of which can be biological decomposition and wastewater sludge treatment. At the same time, by utilising the energy generated from solid and liquid waste, part of the fossil energy resources can be replaced through the reduction of harmful substances.

However, regarding adaptation to climate change, water management and the supply of water have much higher importance. Both heat waves and drought caused by climate change as well as the extreme whether situations (thunderstorms, rainstorms, floods) seriously affect water management, surface drainage and drinking water supply. Unfavourable meteorological events directly damage the infrastructure; in hot weather, the increased demand for water becomes harder to meet; the reduction of the effects of floods means a great challenge in the fields of prevention and planning. Furthermore, there are solutions which serve the protection and replacement of groundwater in area of settlement or entire regions, thus having an indirect role in moderating the effects of climate change. Wastewater treatment is more and more closely connected to the whole of the water management system both technologically and regarding the principles of operation. Integrated water management systems treat the whole water cycle as a unified, harmonised process starting from the sources through the water supply network to the entire system of utilisation and emission, including also the regulation of land use and of some business activities using water. At the same time – unlike in the case of mitigation – waste management is less affected in terms of adaptation: in this respect, environmental safety is important when preparing waste landfills to resist extreme weather conditions.

8.1. PREPARATION OF WATER MANAGEMENT FOR EXTREME WEATHER SITUATIONS

The water management principles that are currently considered conventional were developed in the 19^{th} century assuming a much higher load-bearing capacity of the environment than what is in fact, acceptable today (water abstraction, wastewater treatment, and canalisation). At that time the importance of water was assessed applying a much narrower set of criteria than today. These principles are not effective anymore because of increased demand and impact on the environment by contemporary society. Additionally, the relevant environmental effects (extreme rainfall, drought, storms, heat-waves) taken into consideration and the requirements (flood and erosion protection, safe and secure water supply, demand for a more nature-friendly urban environment) have also transformed to a considerable extent because of the change in climate. Therefore, the implementation of sustainable water management is necessary and useful in itself; however, climate change makes it absolutely indispensable even in regions well-supplied with water.

It is generally true both in the cases of water management and flood protection that adaptation cannot be implemented in itself but only by inserting it into the whole catchment system. It is also practical to review the technological implications of water management in urban areas within its system: separately the measures targeted at the reduction of surface flow and the treatment of problems caused by water streams. This is true even in case of a more local intervention – carried out for example, in a park or a part of a settlement: its effects on the wider area must be known already before implementation. This way, also those effects and solutions which occur beyond the settlement both in terms of territory and authority will receive sufficient attention.

There are multi-level effects exerted by climate change on water management and on the possible responses in adaptation; and these also depend on the characteristics of the influenced environment. The table below outlines these effects and reactions.

Effect	Adaptation
Long-term droughts	Water retention; water saving
Increasing water consumption	Water saving; water utilisation based on non-drinking water
Floods caused by rainfall of extraordinary intensity and consequent erosion	Water retention in outlying areas of settlements; sustainable flood protection in both external and internal areas; urban drainage based on integrated water management
Rising sea-level, increasing storm surge and resulting erosion	Complex protection systems

Table 2: The effects of climate change on water management and the possibilities of adaptation

It is a special feature of climate change that too much water and too little water can cause problems at the same time. The intensity of rainfalls may increase even in those areas which are otherwise becoming drier; and this is going to be a tendency in most of Europe according to most of the forecasts. Therefore, flood protection has to get prepared for rapid and unexpected floods while water supplying systems have to be ready to handle shortages of water within the same year. On the settlement level, extreme rainfalls are important mainly from the point of view of flood protection, while water shortage is crucial mainly from the perspective of drinking water supply. It is important to call attention to the relative nature of water shortage. A lower quantity of precipitation – though not obviously extreme – may also cause a drought in an area which is used to better water supply; furthermore, an upset in the balance of consumption and supply may also cause shortage of water – which is not necessary a result of a reduction in the quantity of accessible water reserves. Such case for example is increasing urban water consumption during heat-waves or the extreme growth of towns and the change in water consumptions habits. At the same time, drought and water shortage affect agricultural production and land use in the surrounding areas, which in turn, have an impact on the towns.

8.1.1. Water drainage

The first step in sustainable water management is to preserve the quantity and quality of groundwater and to support infiltration instead of surface runoff. The preservation of groundwater quantities is supported by **water saving** and the **utilisation of alternative water sources.** The former is discussed in more detail in Chapter 7 about sustainable construction, while the utilisation of non-drinking water is discussed below within this chapter. The reduction of surface runoff and the facilitation of infiltration into the soil are methods to decrease erosion and flood risks due to high-intensity rainfalls. By preserving/increasing the moisture content of the soil, water can be retained for periods when droughts occur more frequently either for the needs of the vegetation or for the purpose of water abstraction from under the surface. More humid soil and lush vegetation have a positive effect on urban climate especially during heat-waves.

In connection with climate change, it is more and more important and an increasing emphasis is given to the fact that urban water surfaces also have micro-climatic, aesthetic and recreational effects, which also require water retention and preservation.

In urban areas, the best way to accomplish these tasks is by establishing a **sustainable urban drainage system** (*SUDS*), which has been elaborated relatively well both as a theoretical concept and as a practical application. Despite the fact that there have been several progressive investments all over the world, as well as a substantial amount of available literature in the subject, the number of actually operating systems is rather low. The essence of traditional drainage is that the rainwater should be collected from the built-up areas as soon as possible and as much in a regulated way as possible. Climate change and sustainability however, requires the preservation of water and surface drainage similar to natural runoff. For this reason, 'the objective of sustainable urban water management is not only the safe and efficient collection of surplus waters and the regulation of water quantity but also to realise aesthetical, recreational, ecological and economic advantages, including the value growth of the area in question.' (J. Gayer, F. Ligetvári, 2007).

Accordingly, the following objectives can be allocated to serve the purposes of up-to-date and sustainable urban canalisation and water management:

- decreasing of urban runoff in order to reduce peak runoff;
- reducing pollution by collecting and treating pollutants occurring in the urban catchment area;
- retention of rainwater and its utilisation to the maximum extent at the location or in its vicinity;
- improvement of the cityscape: instead of hiding water, making it visible by integrating it into functional green areas;
- reducing the infrastructural costs of canalisation by, for instance, directing rainwater to green areas.

The system borrows several ideas from water retention methods applied outside buildings in sustainable construction practices. Their regional-level employment requires a much more comprehensive system; however, the technical solutions are similar in many cases.

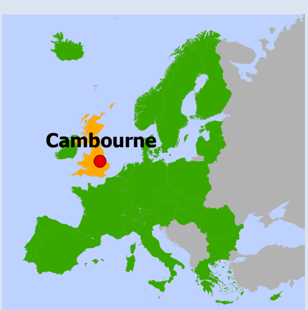
The system is composed of the following (B. Woods – R. Ballard et al., 2007) :

- **Bio filter strips:** Longitudinal, shallow strips and ditches planted with water plants, which are capable of filtering out mainly the suspended pollutants. Vegetation provides excellent filtration as it absorbs some of the dissolved contamination, and at the same time, it also causes sedimentation of drifting solid substances by lowering the speed of flow, furthermore, because of the roots, vegetation has an infiltrating effect by which it mitigates erosion, cleans up the runoff water and also reduces its quantity.
- **Pervious pavement:** Pervious or permeable pavement of roads and sidewalks allow rainwater to go through the surface. The water infiltrated this way can directly get to the soils below or to the sub-surface sewer network or to rainwater treatment plants. The pavement may be made of pervious concrete, bricks, block stones, granular stone cover without binding material or stone cover laid with open joints. Its main advantage is that it does not require separate space but it can be used as part of ordinary architectural solutions, and thus it enables the channelling of water directly into the soil even in areas reserved for traffic. There is another beneficial side-effect: pervious pavement reduces the danger of slipping in rainy and especially, snowy conditions as a result of a rapid collection of water from the surface. However, it has a limited drainage capacity.

Its disadvantage is higher costs (two or three-fold of the costs of traditional asphalt pavement), lower load-bearing capacity and sensitivity freezing. In order to avoid damage by freezing, careful construction is required. There is a danger of clogging; therefore, regular maintenance should be performed to prevent it.

- **Swales:** Traditional open swales are more common in settlement parts which are characterised by family houses or village features. Because of their size, they have a considerable role in infiltrating rainwater into the soil; however, because they also serve as watercourses, they are not able to efficiently withhold intensive rainfalls.
- **Balancing ponds:** Balancing lakes or ponds are similar to stormwater basins but are smaller, a few tens or a hundred square metres in surface area. These are usually shallow basins serving as temporary storages of rainfall received through the swales. They provide excellent possibility to be harmoniously adjusted to the environment by planting water vegetation and establishing parks around them.
- **Percolation (or infiltration) trenches:** These are trenches filled with loose granular material (crushed rock or gravel), which leads surface water into the soil or the sub-surface sewer network, while it withholds larger-sized suspended substance. Because of the filling, there is hardly any need for maintenance; and it is less dangerous in terms of accidents than traditional ditches located next to the sidewalk because they are level with the surface.
- **Infiltration basins:** These basins are similar to balancing lakes except that the construction of their floors enables water to migrate back into the soil. An infiltration basin is the end-point of the local water network; from here water does not usually continue its way on the surface. In this case, suspended material coming in with the rainwater cannot leave the system; therefore, regular cleaning and skimming is required.

The main advantage of a sustainable sewer system is the achievement of the main target: water retention. In addition, as it is mentioned above among the objectives of planning, it also contributes to establishing an aesthetic and comfortable urban environment. Its construction supported by the above technological solutions is considerably cheaper than that of traditional water drainage systems; and its maintenance costs are also lower. Among the limitations on its application, the protection of water quality has to be mentioned first, as only appropriately clean water can be channelled back into the soil. This is even the more important because in the urban environment today surface runoff is often more contaminated and more hazardous than household wastewater (for example, when public roads are salted in winter). Therefore, in the case of contaminated surface runoff (for example, in the surroundings of roads and petrol stations) a sustainable sewer system can be applied only if the water is suitably treated/cleaned. This can be achieved, for example, –by letting water infiltrate through pervious road pavement not directly into the soil but first to a reservoir or treatment plant through a sewer system. Another important restrictive factor is the water uptake capacity of the soil. Low-porosity, compact clayey and muddy soils are not able to absorb the infiltrating water rapidly enough and in sufficient quantities; therefore, in these situations the system cannot operate. The high sediment contents of the runoff water may also hinder infiltration. An increase in groundwater due to infiltrating surface water can result in a lowered load carrying capacity of the soil as well as in increased humidity in lower areas or in cellars in case planning was not careful enough.



Lamb Drove/Cambourne, Sustainable Drainage System

Lamb Drove is a part of Cambourne, which is a new settlement located west of Cambridge in East England. Its total number of inhabitants is expected to be 10 000.

During the construction of this part of the settlement, special attention was given to the introduction of different instruments of sustainable water management and drainage. In the project launched in 2004 different technical solutions were applied in order to achieve the slowest possible runoff and to retain rainfall at the location as much as possible (rainwater storage tanks at residential houses, green roofs, installing water-saving equipment, pervious pavement of public areas, swales, temporary reservoirs and infiltration basins).

The system is both significantly cheaper and more robust compared to traditional sewer systems both in its construction and maintenance. According to approximate calculations, at 2006 prices, GBP 11 thousand was saved in connection to its construction and annually GBP 30 by apartment related to its maintenance. Besides these savings, the success of the investment is also proved by the measurements taken in course of the monitoring activity of the project: in the sample area, significantly smaller quantity of water runs off the surface, and also, in a delayed manner, than on the control site. The final monitoring report will be completed by early 2011.

The investment was carried out as part of the Interreg III B FLOWS (Floodplain Land Use Optimising Workable Sustainability) project and the project owner was the County Council of Cambridgeshire.

Contact person:
Juliet Richardson
E-mail:
juliet.richardson@
cambridgeshire.gov.uk
Shire Hall
Phone: 01223 715541
E-mail:
planning@cambridgeshire.gov.uk

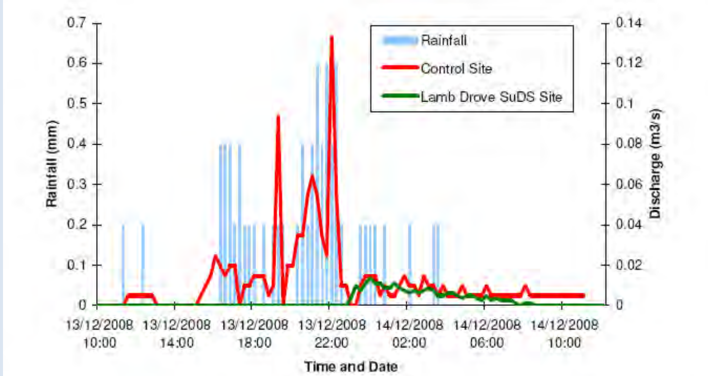
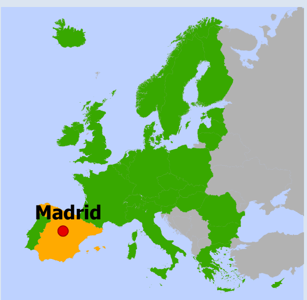


Figure 4.2 Comparison of Discharge at the Lamb Drove SuDS site and the Control Site on the 13th and 14th of December 2008

Figure 31: Comparison of surface runoff measured in Lamb Drove and in the control area



Gómeznarro Park, Madrid, park refurbishment with stormwater retention

Gómeznarro Street and the belonging park area are located in the southern region of Madrid, in Hortaleza District in Canillas part of the city.

There is a considerable danger of erosion in the park and its vicinity. More intense rainfalls caused flooding of the lower parts of the built-in areas. Therefore, in January 2003 – following careful preparations – the creation of the surface drainage system was started in the area and was completed already by May of the same year.

The following work was carried out in a total area of 10 000 m^2:

- demolishing the water-tight road pavements;
- replacement and restoration of the damaged and compacted soil;
- establishing sub-surface collection and infiltration tanks and the connecting collecting and distributing sewer network under the sidewalks;
- construction of sidewalks with permeable pavement;
- developing parks and restoring existing vegetation.

As a result of these (re)constructions, the total amount of the incoming rainwater remains within the area and there is no considerable surface runoff. What is more, moisture problems in buildings and erosion were eliminated, and a comfortable green area was established; furthermore, the load on the urban sewer network was also reduced. The costs (EUR 343 600) were covered by the Municipality of Madrid, and in 2004 the project was nominated for the best practice award of the UNO Habitat, where it received the qualification of 'good practice'.

Contact Person:
Javier del Palacio Fernandez-Montes
Ctra. de Canillas, nş 2, 28043 Madrid, Spain, Hortaleza District Council
Phone: 91 588 76 43
Fax: 91 588 76 49
E-mail: palaciofj@munimadrid.es

One of the possible incentives of local rainwater retention – which has come recently to the foreground, but is also rather contradictory – is the '**rainfall tax'**. Its main feature is that a part of the handling costs of rainwater drained through the canal network will be devolved to consumers who own large sealed surfaces, and its extent will depend on the size of the roof or the surface of the water-tight cover. The expression 'tax' is not necessarily correct since where it has been introduced so far, water suppliers define and collect this sum. However, also local governments may impose it, thus it can function as a local tax. Indeed, the payment imposed this way affects the inhabitants who own less sustainable means of water drainage; however, it has also some fundamental disadvantages. Firstly, this solution incites the tax collectors to sustain their income and the outdated solutions rather than to support modernisation. At the same time, the consumers do not generally have the resources to modernise (to build green roofs or permeable pavement), all the more so as they have additional expenses owing to the tax itself. Another problem is that a great share of the buildings having the largest water draining seal are not profit oriented, but non-profit buildings, schools, community or ecclesiastical buildings, which have low revenues. Such extra expenses can even make their operation impossible. A more suitable solution would be therefore, if instead of a one-sided burden sharing, the tariff system would also support the modernisation of old buildings and would distinguish between buildings of diverse purposes; furthermore, if, as a first step, water retention solutions were made obligatory for new constructions.

8.1.2. Making use of alternative water sources

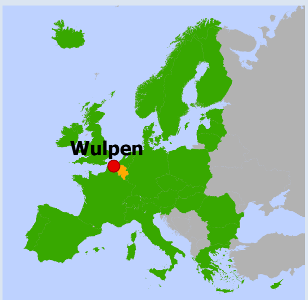
Water consumption based on non-potable water (*dual piping*) saves water, but it does so by influencing mainly the output end of the water network. In Europe, because of the strict public health regulations, only those water sources are regarded as established which provide water of appropriate quality. The exploitation of water reserves of non-potable quality is mostly missing; however, the re-utilisation of treated wastewater is already widespread in industry. There are two sources that can be considered: re-utilisation of treated wastewater and the use of collected rainwater. It is interesting to mention that in Singapore sea water is used for toilet flushing. There is no reason why this could not be implemented also in European cities provided that the issue of corrosion is solved.

The total transformation of the piped water supply system to dual piping is very expensive and complicated; not to mention the extremely high public health risks in case of a potential leakage. For this reason, the most expedient solution is to utilise rainwater or appropriately treated wastewater only for certain, well-defined purposes, such as the irrigation of parks and agricultural areas, fish breeding, and the dust abatement of construction and mining sites or roads.

Considerable water saving can also be achieved by **utilising the water discharged by wastewater treatment plants.** The amount of water leaving from the wastewater treatment plants and led to surface waters represents a considerable loss from the point of view of local or regional water management as it is not returned to the location of abstraction. This is especially true for supply based on groundwater reserves. Where soil conditions allow, infiltration of water into the soil can also be applied. Soils with an appropriate pore size – similarly to the operation of the bank-filtered wells - can perfectly filter the infiltrating water; this way it is possible to restore groundwater without deteriorating its quality. On the one hand, the water treated like this supports the vegetation in the periods of drought, and on the other hand, the restored groundwater can later be exploited and thus the costs of constructing artificial reservoirs can be spared. Root-zone wastewater treatment is the simplest solution for utilising the treated wastewater since a part of the water is directly used by the vegetation, and because a water habitat fits better with the treatment plants in terms of both landscape aesthetics and land use. This can also be implemented on a smaller scale: individual wastewater treatment systems can also supply water for irrigation of gardens and parks.

The main disadvantage of this solution is the hazards posed by chemical pollution (e.g. detergents, pharmaceuticals) which cannot be removed by the usual treatment of wastewater. This is especially true if the treated wastewater is used to replenish the groundwater base. When it comes to chemicals occurring in a low concentration, it is extremely difficult to detect those because, compared to more common water-polluting substances, there is a high number of potential chemical compounds in urban wastewater which have to be checked. In addition to the technical difficulties of performing regular tests, there are no established regulations concerning the threshold limit values of several, potentially dangerous substances for the reason that those could not occur in drinking water. In the utilisation of recycled water for non-potable purposes, for example irrigation or fish ponds – the nutritive content of the treated water, especially its nitrogen content can be an important restrictive factor.

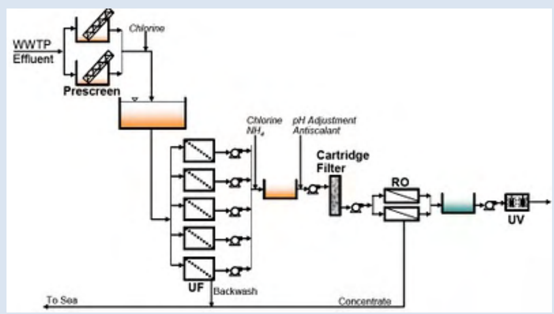
Currently, the most appropriate equipment for eliminating contamination seems to be the ones operating based on reverse osmosis. For now, drinking water production from wastewater with reverse osmosis only takes place in Malta, and mainly with the purpose of demonstration. In Belgium water treated with extraordinary care is led to the water base through the soil; so it is not utilised directly but through the standard wells, as drinking water. In Europe, treatment and recycling of wastewater is not a common practice unlike in United States or Australia.



Torreele, the recycling of treated wastewater as drinking water

Wulpen is a small community of 520 inhabitants situated on the coast of Belgium, 38 km from Brugge.

The first and to date, in Europe, the only considerable groundwater replenishment from treated wastewater was implemented here next to the local wastewater treatment plant. One objective of the investment was to restore the St-André water base with recycled, re-utilised water. The quantity of extractable water could not be increased anymore; therefore, the regional waterworks found communal wastewater treatment as the most applicable alternative source.



The water received from the Wulpen wastewater treatment plant, operating since 2002, is treated with ultra-filtering and reverse osmosis; and it also receives chemical treatment to the extent necessary. The last step in the treatment process is disinfection with UV light; however this is not necessary under normal operating conditions. The treated water gets to the groundwater through an infiltration basin. The groundwater extraction wells are located at a minimum distance of 40 m from the basin. The water extracted from the wells is aired and forwarded through a sand filter and then it gets into the network as drinking water.

The capacity of the plant is 2.5 million m^3 of water. Thanks to this, the amount of abstracted groundwater could be reduced by 30%, i.e. by 1 million m^3 per annum, and the groundwater level also increased. By operating the system, water hardness was also considerably reduced, almost to its tenth.

The investment and the trial operation were performed by the regional waterworks Intercommunale Waterleidingsmaatschappij van Veurne-Ambacht (I.W.V.A.), and the plant is operated by Aquafin NV, which also runs the wastewater treatment plant. The total costs amounted to EUR 6 million, which however, also includes the development itself.

Contact:
Emmanuel Van Houtte
Intermunicipal Water Company of the Veurne Region (I.W.V.A.),
B-8670 Koksijde, BELGIUM Doornpannestraat 1,
Phone: +32 58 533 833,
Fax: +32 58 533 839,
Email: emmanuel.vanhoutte@iwva.be
Source: www.iwva.be/docs/torreele_en.pdf

Rainwater collection has considerable traditions also in Europe. It is relatively simple and inexpensive to collect the rainwater and snow melt-water from the roofs. Water collected this way is mostly used locally for irrigating gardens or it is led into the soil. These local solutions belong more to the competence area of sustainable building (Chapter 7); this practice, however, can extend to entire settlements if precipitation water is collected from larger areas in a systematic way, and the gained water is stored in greater quantities to be utilised for public purposes. Leading the collected water into the soil supports water retention, as described above within the framework of sustainable drainage; therefore, it only affects water utilisation when, after the level of the groundwater is restored, water is abstracted from there again for the purposes of drinking water, for example. As to rainwater collected from urban areas, the treatment is absolutely necessary before use even for the purposes of irrigation or agriculture. From a technical point of view, retention basins are perfectly applicable for the storage of rainwater as well.
Thanks to their self-purification ability, lakes with a natural basin, vegetation, and a permanent water surface represent the solution that has the most positive effect on water quality. Wherever creating lakes of this type is not an option, a possible solution could be the construction of underground reservoirs. These can be located even in busy urban environments such as, for example, under parking areas.

The advantages of underground storage lie in the facts that it reduces the rate of water loss caused by evaporation to the minimum and that water quality is preserved as the excess growth of algae is avoided. When using closed reservoirs, it is very important to use an inflow filter to retain any solid waste or leaf-litter. While this may not be necessary in the case of open reservoirs surrounded by vegetation, a waste screen may still be needed.

8.1.3. Flood protection

Floods are natural phenomena which cannot be prevented; however, some human activities and climate change contribute to an increase in their likelihood and adverse impacts. The causes and consequences of flood events vary across the countries and regions of the European Union. Since 1998 there have been 100 major floods in Europe, causing about 700 fatalities, the displacement of about half a million people and at least €25 billion in insured economic losses.

Flood protection is closely related to other processes taking place within the catchment areas such as the quantity, intensity, and form of precipitation, melting and freezing, or the rate of infiltration versus drainage. In turn, these are influenced by factors many of which do not directly form part of flood protection such as building density, land use, and forms of farming. Therefore, one of the basic principles of effective flood protection is seamlessly incorporating flood protection into the system of **integrated water management** or even integrated environmental management. Implementing this is one of the most important tasks. Accordingly, the solutions mentioned hereunder cannot be applied on their own either, partly because of the interactions resulting between the interventions, and partly because the flood protection/water management system can only function effectively if it operates in a harmonised way. Regional and catchment area based planning and intervention must be inevitably implemented as flood protection and river control cannot possibly be the task of a single settlement. For this very reason, the possibilities of adaptation and protection at the settlement level are very limited.

It follows from the very essence of climate change that, regardless what flood protection issue or solution is in the forefront of thinking during the planning process, relying exclusively on the customary, observation-based flood risks (such as the probabilities of given water levels occurring within given timeframes) is just not sufficient. Modelling precipitations and surface runoff on the basis of climate models must inevitably serve as the starting point of planning. The importance of this idea is continuously proven by the fact that extremely large-scale and ever more violent floods are becoming more and more frequent. Therefore, in the field of adaptation, one of the most fundamental steps of flood protection is **modelling**. Modelling affects all areas and helps foresee expected new outflows and runoff conditions. Then the specific development projects to be implemented can be based on this foundation.

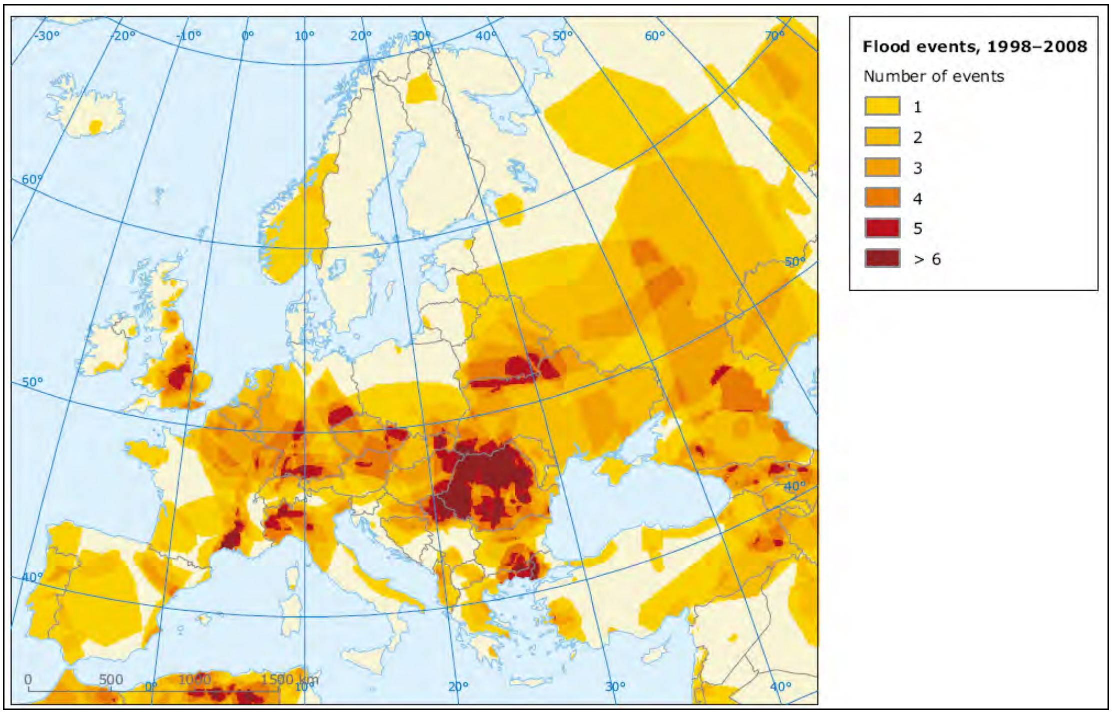


Figure 32: The frequency of flood events in Europe between 1998 and 2008 (Source: EEA, 2008b)

One main step of flood protection is to measure the risks properly. 'Flood risk' is the combination of the probability of a flood event and of its potential adverse consequences for human health, the environment, cultural heritage and economic activity. Flood risk assessment is in close relation with vulnerability assessment. Based on data on relief, precipitation, runoff, land use etc., the flood risk map and risk assessment highlight the most vulnerable areas and provide fundamental information for proper management activity. In the age of GIS, digital elevation models and climate change modelling, flood risk assessment has a sophisticated IT background, which facilitates the evaluation of not only the current risk situation but of potential future flood hazard, too.

Flood risk management is the social and engineering activity which can respond to the problem. This activity encompasses a rather diverse set of tasks, but there are some key elements applied in every case:

- Prevention: averting the risk of floods by means of land use management.
- Preparedness: using real-time flood forecasting to have sufficient amount of time before the incident happens.
- Emergency response: organizing the work of authorities during floods, and securing inhabitants against the effects of floods.
- Recovery: providing financial and material assistance for the remediation of the affected settlements.

One must always, in all areas of action, consider a fundamental principle: **maintaining complete flood protection often proves impossible over the long run**. Modern cities have sprawled into inevitably unsafe bay areas and floodplains. In these areas defence may require more of a sacrifice than what the valuables defended are actually worth, often simply because flood protection in these areas leads to the emergence of higher peak flood levels in other areas. What is needed is reasonable urban planning that respects environmental limitations to a greater degree. Possibilities must be found to secure adequately large expanses of spaces where water can run its course even in times of flood and where the natural processes (river bed changes, sedimentation and erosion) can also take place. Rivers must be given their space and it must be accepted to a certain degree that the most threatened areas will be flooded regularly. Major land use restrictions and rehabilitating the natural environment may be necessary in order to avoid that the implementation of river control and flood protection becomes ever less sustainable and ever more costly because of the fact that it relies on environmentally detrimental interventions.

In downtown areas, whenever there are adequate open surfaces that are not built in, **sustainable urban drainage systems** (SUDS; see described in the paragraphs on water retention) may increase infiltration, which in turn can significantly decrease the floods of minor water courses. However, the possibilities of such a system are limited; besides, it does not offer any protection against large amounts of water from external sources. Because of the building density, such protection is hardly possible by means other than **strengthening dams and embankments** to increased load-bearing specifications that take climate change into consideration.

In most heavily built in areas, the application of **mobile walls** may be the solution. Mobile walls are metal sections installed on-site, immediately prior to defence becoming necessary, using preinstalled foundations and permanent support pillars. This defence solution needs a very small surface area and does not permanently restrict access between the river and the protected areas. Water-filled hoses, a more modern and faster version of traditional sandbag defence, offer a similar solution. In this case water-tight, water-filled hoses of an adequate diameter (as much as one to two meters) act as dams. The water it takes to fill them is taken from the fire hydrants usually available in the urban environment. This ensures that the hose is 'blown up' to the required diameter and weight to ensure that it is not swept away by the flood. These hoses may have a length of 100 meters or more, facilitating the defence of entire city districts, but they are also suitable for protecting just a specific building. The advantages include not having to preinstall any structures, quick installation and transferability, and some cost saving because there is no need for building dams. However, this solution is not suitable as a form of protection against larger floods. Another version of the mobile wall is a water-tight wall system built using prefabricated plastic elements. This system is also used in a manner similar to sandbags. These last two systems have the added advantages that they are reusable several times, filling them up and installing them does not require heavy physical work, they are easy to handle, and they can be disinfected after the flood, therefore not becoming hazardous waste. Fully mobile walls are made even more economical by the fact that they do not need to be purchased; they can also be leased. This enables less affluent settlements to use them as well. The disadvantages lie in the fact that their protection capabilities are limited and that they need storage space during flood-free periods. Another factor restricting applicability is the quality of the surface upon which these systems are installed. Unlike in the case of a dam built from soil, here the surface materials are not protected from water and thereby may be underwashed. The inclination of the surface may also restrict applicability.

As a last resource, the solution may be **strengthening or raising the height of buildings and infrastructure** in the areas most exposed to flooding in order to weather occasional floods, or to **exclude** these areas from human activity. As flood protection systems are widely available in Europe, **improving the individual waterproofing of buildings** is a less frequently used solution. However, limited floods that last for a short period of time may be managed using this method. In practice, increasing the height at which ventilation holes and incoming pipelines enter the buildings, providing these holes and entry points with appropriate sealing, and rendering low-level walls waterproof help avoid the flooding of the lower parts of the building. In addition, watertight panels installed into or in front of doorways that function similarly to mobile dams may also prevent water from flooding the building. This type of flood protection wall may be raised along the full length of the buildings, such as, for example, in the case of large shop windows. Using these solutions might make sense in places where regular low-level floods are expected to occur such as, for example, in the case of waterfront resorts, where permanent dam systems cannot possibly be implemented. These solutions help decrease damage significantly; however, implementation must be of a high professional standard, and these solutions do not protect any areas or streets outside the buildings and do not facilitate traffic.

The concept of **buoyant buildings** and city districts is also of great interest. Of course, this rather costly solution is only needed in areas most exposed to flooding such as in Holland and, in general, in low or sinking shoreline areas, mostly nearby river estuaries. Nonetheless, in these special areas buoyant buildings can be very practical solutions as, for geological and climate related reasons, dam reinforcement in these areas would require never-ending and, after all, irrational development projects. For the time being, very few actual examples exist. Buoyant buildings have been built in the Netherlands since the turn of the millennium, and there are plans to make whole city districts buoyant. The basic idea is very simple: the buoyant buildings, which form traditional streets and rows of houses, are fastened to pillars in a manner that allows vertical displacement but does not allow the buildings to drift away. When the flood comes, the buildings rise on the back of the swelling water but practically no damage is done. However, based on the experiences thus far, this type of development remains both isolated and uneconomical as society is not really forced to maintain city districts at such high costs.

Double precipitation canalisation is a solution halfway between flood protection on the one hand and developing the sewer system on the other. The basic idea is doubling the traditional, low-capacity sewer system, which serves the purpose of draining more frequent but lower intensity precipitation peaks (small or comfort system), by creating a parallel network consisting of large-capacity elements that can tackle extreme loads. This parallel second system can be the road surface itself if it is designed and implemented appropriately. This method of draining excess water into less populated areas and parks costs very little while it avoids flood damage, and, more importantly, it helps decrease flood levels and thereby protect areas that are really valuable. Implementing a system like this requires the in-depth harmonisation of urban planning, flood protection, and infrastructure development, even though the actual material costs are negligible.

Areas outside human settlements offer much greater opportunities for implementing effective flood protection systems. However, these solutions are usually beyond the means and competences of any given settlement. **Widening the floodplain** increases the floodplain's storage capacity and reduces the level of the flood wave. However, this is not an option in the case of rivers that cross settlements; if the wide floodplain narrows down right upstream from a city, the flood level – and thereby the risk of flooding – may actually increase within the settlement's downtown area whenever the storage capacity upstream from the settlement proves insufficient. **Temporary water storage outside the floodplain**, a solution seen in the New Vásárhelyi Plan in Hungary, helps reduce flood levels, generates new economic opportunities, and creates (or reinstates) semi-natural habitats across wide expanses of land. In this scenario, some of the flood water is channelled into temporary reservoirs located along adequately safe river sections on the protected side and themselves protected by dams. This helps reduce the outflow during critical periods. Once the flood-wave has passed, the water may be drained and the area can once again be used, typically for extensive farming, until the next flood arrives. A disadvantage of the solution is that it can only be implemented if the terrain is suitable for the purpose. If implemented with due care, **river control** can also have a favourable effect on flood protection; however, whether this method is suitable can only be decided on a case-by-case basis as it requires extremely thorough planning.

In the case of smaller water courses or springs, even in hilly or mountainous terrain, a well-known solution is constructing **retention basins**. These are effective measures against floods caused by sudden, high-intensity local precipitation. The water so collected may be used for irrigation either directly or through infiltration into the soil during droughts in an effort to improve the area's water balance. There are several types of basins according to their principles of operation:

- **Transitional or 'dry' basins** (detention basins) are used to temporarily store excess runoff water during floods. The water introduced into these basins during downpours or floods is stored until the flood-wave passes and then gradually drained, leaving the basins mostly dry outside their periods of use. Since there is no permanent water environment in these basins, water quality tends to deteriorate rather than improve during storage.
- **Wet basins** (retention basins) are basins with a permanent water surface and landscaping appropriate to their environment. In addition to flood protection, they are also used for water retention. As they maintain natural aquatic habitats, they do not contribute to the deterioration of the water stored. The water collected in these basins may be used to improve water supply during periods of drought. As the water introduced into these basins is only used after a longer

period of time, there is enough time for sedimentation; this, in turn, requires continuous maintenance and the regular removal of the sediment matter.

- **Infiltration basins** differ from the types of basins described above in that the incoming water is not stored primarily as surface water but instead it is infiltrated into the soil, something made possible by the specially designed basin floor. This solution can only be used if the geological conditions are suitable, the soil is stable, and the infiltrated water is pure (given the fact that the water introduced is untreated water received from natural water courses), otherwise infiltration may lead to increased groundwater pollution, marsh formation, and even landslides in inclined areas.
- **Stormwater retention basins** can be implemented even in urban areas, for example as parts of a sewage treatment plant if a combined sewer system (sewage transport and precipitation drainage) is available. This solution already forms part of preparing treatment systems for climate change.

Preparing the local population for flood protection and disaster management is very useful and may be implemented at a low cost. Besides thorough defence plans, the education of the residents and their involvement in defence activities and the organisation of alarm and monitoring networks can offer significant support to disaster management agencies in performing their activities.

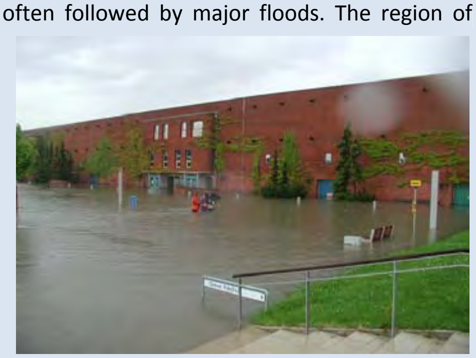
Greve, flood action plan

Located in the Sjælland region just 21 kilometres from Copenhagen, the Danish city of Greve has a population of approximately 47,000.

The city is located on a low plain near the sea. As a result, both massive precipitation and rising sea levels represent a flood hazard. After the great floods of 2002 and 2007, the city's municipal government decided to elaborate a climate change mitigation strategy. In elaborating the strategy, citizen accounts of the 2007 flood were recorded and taken into consideration along with meteorological data, forecasts, and GIS data obtained through a land and building survey.

As part of the strategy, the region's water draining system is renovated every 10 years, which always includes a capacity increase as well. GIS modelling was used to create a flood hazard map to indicate which areas are most exposed to the hazard of flooding. During the project, data collection and monitoring is continuous.

Implementing the strategy has brought visible results. During the first two weeks of August 2010, many parts of Denmark were exposed to downpours of extreme intensity, often followed by major floods. The region of Greve also saw an unusual amount of precipitation, as much as 100 mm within just a few days. However, thanks to the information processed in advance, the damage suffered by the settlement was minimal.



Contact:
Charlotte Wernersen
Regional and Environmental Planning Agency
E-mail: chnwe@blst.dk
Web: www.greve.dk

8.1.4. Coastal regions and climate change

Coastal regions face the most specific impacts of the changing climate. While other areas are not affected in all fields of human life, in these regions the climate change has a significant effect on every aspect of life. The increasing sea level, storm surge height and frequency, higher peak river flows, coastal erosion threat even the existence of coastal cities. The historic cities of Greece, Croatia or the British Isles are especially vulnerable as the tourism – that would be so also affected – has a fundamental role in their economy. Coastal wetland ecosystems have an important role in the cities' life as well, as they are the base of local economy and provide defence from flooding. Another important aspect is the water supply, as rising sea level causes salt water intrusion and increases the salinity of ground water. The importance of these problems is so high that the EU issued the Communication from the Commission to the Council and the European Parliament on integrated coastal zone management: a strategy for Europe (COM/2000/0547).

The scale of the problem (109,000 km of coastline only in the EU 27 states) in itself limits the possibilities of adaptation. In most cases the only achievable solution is the revise of land use based on the modelling of sea level rise and erosion processes. This is not easy or cheap; the relocation of roads, electric lines, etc. even in an uninhabited area is very expensive. But, as the coast is a focus point of the European culture and human activity, there are regions, and of course the coastal cities, where we must find solutions to the challenge. This chapter aims to give some recommendations to this adaptation strategy.

The great complexity of human activity, land use, economy and nature reservation made the use of integrated planning obvious, as in almost every case in the water management. Plans have to consider that coast is a dynamic system, and the natural environment has far more greater influence on the coastal cities than their inland neighbours. It increases the uncertainty of the future and requires wider approach, more knowledge and creativity from the planners and municipalities. The preparation for unexpected changes needs the use of adaptive management approach. The plans and measures have to be flexible and renewable. As a management approach, it is based on implementation, monitoring, and periodic reassessment of adaptation measures.

The adaptation strategies are based on one of three general principles:

1. Protection: to avoid the occurrence of hazards in the protected area;
2. Accommodation: not to avoid, but at least to reduce the impacts of the hazard;
3. Retreat: moving away from the source of the hazard.

Coastal erosion

About 20% of the European coastline is considered to be posed to erosion. The higher share of erosion affecting coasts is at the Mediterranean Sea, while the Baltic Sea is the only region where the accumulation type coastline is longer than erosion type (EUROSION, 2004). So protection against demolition power of waves and currents is an important issue in European scale.

In the case of cities without a river estuary or bay, where the area can be completely closed off, a range of **flood protection and shore protection solutions** can be used to mitigate the effects of rising sea levels. These do not guarantee complete protection against rising sea levels but may be very useful as defence measures against ever more violent storms and storm surges. They fall into three categories:

- traditional efforts to reinforce and build sea walls, embankments, and dams;
- protecting and reinforcing offshore bars, dunes, and islands along the shoreline by regulating sedimentation (by building sea walls, hedges, and spur dikes) and by preserving the vegetation and by afforestation;
- reducing the erosive effects of the waves on the shoreline by reinstating saline lowlands and shoreline marshes (managed retreat, managed realignment).

The traditional solutions **(embankments, sea walls,** etc.) have been used for a long time with well-established practices of application; in fact, there is hardly any other option when it comes to built-in urban areas, rocky shorelines, and lowlands. This is the case in the ancient port cities of the Mediterranean Sea where there is no place to relocate buildings or build regional defence systems. At the same time, just as much experience has been accumulated about the disadvantages of these solutions. Hard structures are not economically viable in every case. No known material withstands the incessant, violent attacks of the waves forever; as a result, dams and sea walls require continuous systematic maintenance and development, something that makes them rather costly. As these solutions only deflect but do not dissipate the energy of the waves, erosion may in fact become stronger along unprotected shorelines in the immediate vicinity of the protected ones. This is why more sophisticated and, luckily, more natural solutions have had to be developed.

Sandbanks and islands along the shoreline are extremely important as far as **breaking the waves** is concerned. This has been very well known in the case of the Frisian Islands. Natural wave breaking structures consisting of loose sediment can only survive if the sediment supply is continuous; this is further supported by vegetation. Artificial wave breaking structures of the appropriate design make currents along the shoreline to be protected deposit their sediment, while protecting the vegetation and afforestation slow the erosion of the existing deposits of sediment. Planting and fertilising non-arboreal vegetation is an option, similarly to how the Dutch polders were reclaimed for agricultural cultivation. Of course, this solution can only be used in the case of shorelines where there is an ample supply of loose sediment matter, such as, for example, on the eastern shores of the North Sea or on the southern shores of the Baltic Sea. An advantage of the solution is that it helps preserve natural habitats while offering regional shoreline protection.

The most recent solution is rooted in the realisation that the energy of waves and wave surges is effectively reduced and dissipated by salt marshes stretching along the shoreline and crossed by wide channels. This is a type of protection that is different in its nature from any earlier system in that it does not stop water at the shoreline but gradually dissipates its energy as it runs ashore, even allowing some erosion. In actual practice, this is nothing else than an attempt at locally reinstating the balance of erosion and sedimentation by recreating the salt marshes and brackish flats that had existed but have been drained, or at creating similar landscapes artificially. The English term **managed retreat** is a poignant expression of how some areas are handed back, in a carefully planned manner, to the natural processes that shape the shoreline. If there is an ample source of sediment in the area, at least the extent of the protected land surface can be stabilised in the long run while allowing the shoreline to change continuously. At the very same time, this solution effectively reduces the erosive effect of storm surges and extremely violent waves, doing so without requiring any major investment or regular rebuilding. These salt marshes are valuable habitats even at the European level, especially for wading birds, wherefore they offer major advantages even in the context of nature protection. A disadvantage is that they may require giving up some cultivated, drained land, and in fact not every affected shoreline has areas that could be used for this purpose.

In the case of seashore cities situated on lowlands, flats, and in river estuaries most heavily exposed to rising sea levels, there is an increasing need to build **complex storm surge defence systems**. In these cases, the classic enclosure-type shoreline protection cannot be applied because river traffic and navigation must be maintained unaffected. These systems mostly serve the protection of the environment of a key settlement; however, they have regional or national significance as far as their dimensions and effects are concerned, wherefore they are far beyond the reach of municipal governments at the settlement level and their applicability remains extremely limited. The solution revolves around using permanent dams and movable surge gates to close off the protected bays and river estuaries during the time of storm surges. The largest such system is the *Deltawerken* in the Netherlands; it regulates the estuaries of the Rhine, the Meuse, and the Scheldt in a unified, regional approach. Other similar but smaller systems are to be seen on the Thames in London (*Thames Barrier*), in the estuary of the Neva in St. Petersburg, and the *MOSE project* implemented on the Adriatic Sea to protect Venice. For the time being, these systems are the only effective instruments against storm surges in the case of open river estuaries. Impressive as each one of these may be as a masterpiece of cutting-edge engineering, several problems also arise.

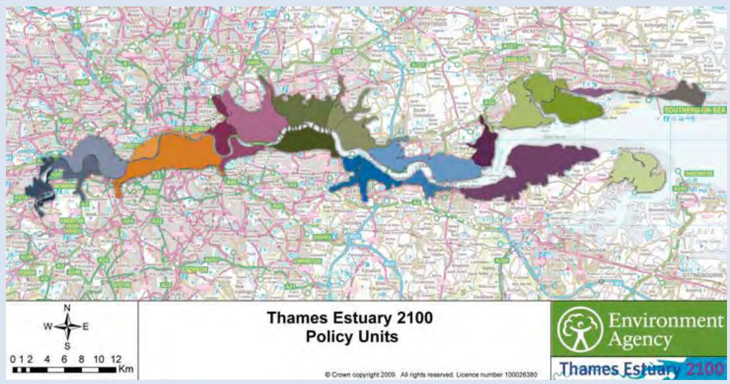
- Construction is extremely expensive and slow and a significant burden on the national economy.
- It follows from the basic principle of the system that it only allows closing the estuary temporarily, just for a few hours during the highest tides, wherefore it is unable to offer any protection against rising sea levels on its own; to this end, additional defence efforts are needed.
- It also follows from the nature of this system that it is not really suitable for regional defence because of the extraordinary scales and costs of investment. Just for the sake of comparison,

implementing the only truly regional defence system, the Deltawerken took nearly 50 years to complete, and its expansion is already underway because of the rising sea levels.

– Because of climate change, the actual permanent sea levels and flood levels can be higher than those envisioned at the time of adopting the plans, something that can easily render the entire system obsolete. Without further expansion, the Thames Barrier is expected to remain functional only until about 2030 if the current predictions concerning the expected rising sea levels prove to be accurate. If the dams are extended, the system may remain in use until the end of the century.
– It takes very thorough and extremely careful planning to prevent sea gate closing from causing major damage to the ecological systems of the area and to the environment in general.

Thames Estuary 2100 project - Managing flood risk through London and the Thames estuary

The Thames tidal floodplain is a low-lying corridor from Teddington in West London to the North Sea along the river. It covers 350 km^2, a home for 1,25 million people and vital institutional and business centres, heritage sites. The region is exposed to high tides and storm surges, so the defence of coast has been a permanent issue from centuries ago.



The existing flood walls, embankments and barriers were getting older and would need to be raised or replaced to manage rising water levels. It was time to make future plans and recommendations on what actions were needed to adapt to a changing estuary. The Thames Estuary 2100 project was established by the Environment Agency in 2002 with the aim of developing a strategic flood risk management plan for London and the Thames estuary through to the end of the century. The strategic aim is to develop a flood management plan for London and the Thames Estuary that is risk based, takes into account existing and future assets, is sustainable, includes the needs of stakeholders and addresses the issues in the context of a changing climate and varying socio-economic conditions that may develop over the next 100 years.

However the action plan does not include concrete infrastructural plans or technical details, it formulates strategic guidelines. This contributes to taking concrete measures in the changing circumstances. Based on risk assessment, the region was divided in 8 action zones and an estuary-wide zone to distinguish the different actions and to give the frame for synchronisation of the work of 23 policy units in the plan area. A public consultation on the plan ran in 2009 and the final plan was approved in March 2010.

The Plan: www.environment-agency.gov.uk/research/library/consultations/106100.aspx

Contact:
Environment Agency
Phone: 0870 8506506
Email: enquiries@environment-agency.gov.uk
Web: www.environment-agency.gov.uk

In addition to these large-scale protection systems, operating **observation and alarm systems** also significantly improves the safety of areas along the shoreline. These systems are inevitably necessary for effectively operating the dams and sluices to begin with; however, they also improve the safety of navigation and the protection of those living along the shoreline as they allow people to prepare for defence in due course of time. Such systems are in operation across Europe along the shorelines of countries like the United Kingdom, the Netherlands, and Spain. As in all cases of disaster management, it is very important to **prepare emergency plans**, communicate them and increase the awareness of citizens by education.

Although major floods and surges cannot be stopped by the homeowners' action, they can significantly reduce the damages in their own properties. The **preparation of private properties** to flood defence is an action in which the local municipalities can play a leading role. This can be achieved by the use of mobile walls, flood-proof architectural solutions (sealing of floors, walls, doors and windows, raising the electricity and air intakes, pipes above 1.5 m from the ground, use of water-resistant materials etc.). The local governance can provide advices, change the building regulations or buy/loan local flood protection equipments (e.g. mobile walls, as mentioned in Chapter 8.1.3.).

8.2. PREPARATION OF DRINKING WATER SUPPLY

As far as the supply of drinking water is concerned, once again, climate change is the greatest challenge both in terms of the quantity and the quality of potable water. Whether water is obtained from surface or underground sources, the amount of extractable water will decrease as a result of the dry and hot periods becoming more typical, right in those periods when, despite all efforts to save water, consumption is inevitably higher than normal. In the case of underground water bases, increased extraction and decreased precipitation create a situation in which the water reserves are not replenished, which leads to the emergence of a range of problems, the available quantity of water being just one of these. With changes in the system of underground currents, large volumes of non-potable or even polluted water may be mobilised; along shorelines, the balance between salt water and fresh water may be disrupted, and sea water may appear in the water base, resulting in the deterioration of water quality.

In most cases, the solutions proposed are based on existing, well known approaches. The first step is always **surveying the extent of the hazard** caused by the changing climate and soil conditions. Trends in available water quantities can be estimated based on expected future demand, water replenishment plans prepared on the basis of climate modelling (taking into account precipitation, natural infiltration, and outflow), and surveying ground water migration systems; and then the necessary steps may be planned.

In the case of underground water bases, **creating** or, as necessary, enlarging **protective areas** and **implementing more effective water use control** are obvious instruments. **Extraction from new water bases** may also be required. These solutions help solve not only quantity problems but also help improve the situation in terms of water quality. In the case of drinking water from surface water bodies, **sustainable water management** as described above in this document can be really useful in replenishing the water base even during periods of drought by building reserves of water stored in the soil and eventually discharged into water courses. **Retention basins** are especially useful in supporting water supply.

However, adaptation is always easier from the perspective of consumption, that is, demand and water use. This approach can partly help prevent the ever increasing water supply problems caused by climate change. At settlement level, the first step towards saving water is **surveying avoidable water consumption**. Examples may include the use of alternative water sources for certain purposes as described above, planting less water-intensive vegetation in public parks, and reducing evaporation and surface runoff by applying appropriate design solutions in public spaces (these include shading and more green areas instead of paved surfaces). Adopting similar measures can significantly reduce the water demand of public spaces.

The drinking water infrastructure has a number of technological solutions to choose from in adaptation.

Reducing losses within the system

Water supply networks go back to a history of several hundred years in many parts of Europe. Damage to old pipes and fittings and leaks can cause significant overconsumption or even water quality problems. Network loss may reach as much as 10 to 20% of the total volume of water supplied, and this water is mostly detrimental rather than neutral in its effect. Today, there are a number of fairly well-established solutions for renovating pipeline networks without fully dismantling the system. However, even a scheduled full replacement of the pipeline network, including the costs of excavation and reinstatement, can be a reasonable option as compared to the damage caused by a disastrous pipeline burst incident or an epidemic spreading along the water supply network. Large savings may also be achieved by operating a fast and efficient repair service as this leads to minimising leak time and water loss during pipe burst incidents and other network defects. Illegal water consumption must also be mentioned as part of the network loss; this can be rather significant in destitute, disadvantaged areas. Solving this problem is however a social policy challenge.

Creating larger storage capacities

Careful planning and water saving policies may not be enough to secure full water supply in all situations, for example, during times of lasting drought. However, the infrastructure may prepare for these periods by creating larger storage capacities. In addition to the customary water reservoirs, retention basins, underground precipitation water storage facilities, and underground natural water bodies may be filled in advance and then extracted as needed. This is a simple but rather costly way to survive the most severe periods in water supply, but it remains a temporary solution as the question of replenishing the water base remains open.

Producing drinking water from non-potable water sources

The above solutions may not be enough in the case of islands and extremely arid areas with very limited water reserves. However, a similar situation may arise in areas where the natural environment offers enough water in terms of quantity but most of it is not potable (such as in Békés county in Hungary). Territories richer in potable water are already more or less regular exporters of water to the arid regions of the Mediterranean. This is the least sustainable solution; however, it is unavoidable until other solutions become effective enough. The political, strategic, and economic risks are extraordinary. In these situations, the solution is converting non-potable water into drinking water. The best known and most widely applied solution is **the desalination of sea water**. An advantage of this approach is that it has been widely used for a long time, albeit mostly outside Europe. Currently, the best available solution is reverse osmosis desalination. Basically, reverse osmosis means that water is pressed through a semi-permeable membrane using high pressure. With pores of an adequate size, the membrane ‘filters out’ not only solid contaminants but also ions and molecules from the water. Using this method, most of the salt content of sea water can be removed. The salt removed leaves the system in the form of a concentrated saline solution. This system has quickly taken over the role of the traditional evaporation method because of its lower energy requirement and easier operation. The water obtained using this desalination method is completely free from salt. Accordingly, if the water is used for human consumption, some of the missing ions must be replenished in the form of minerals, for example by filtrating the water through limestone. This system may be suitable for supplying water even to cities with a large population. In Malta, 57% (!) of the water supplied is obtained from desalinated sea water using this method. The biggest disadvantages of this solution are the costs and the environmental impact of the salty water discharged. The desalination equipment itself is rather expensive as compared to simple water treatment solutions, and its operation is rather energy intensive. Partly because of greenhouse gas emissions, and partly because of the lack of energy, it is a fundamental interest to ensure that desalination methods be based on renewable energy sources. Desalination generates a concentrated saline solution as a by-product. With salt concentrations twice as high as that of normal sea water, it kills all marine life. As a result, the water directly discharged from desalination plants must be appropriately diluted and then discharged into the sea over a large expanse of sea surface.

A less frequently used solution for the removal of unwanted salts is **selective crystallisation**. In this case, appropriately selected reagents are used to induce crystallisation under circumstances ideally adjusted and additives carefully chosen to ensure the right speed of crystallisation of the unwanted ions into solid particles that are then easily filtered. The system cannot remove all cations; however, it has proven its worth in the treatment of very hard waters. There are water treatment plants operating on the basis of this system both in the Netherlands and in Hungary.

Collecting dew (air well)

Dry, cool seashore locations are ideally suited for installing large, appropriately designed condensation surfaces for extracting water from air humidity as a local solution. This technology is currently in the experimental stage; however, its cots are very low, and it operates without any energy systems or complicated purification or treatment methods. The greatest disadvantage is that its capacity is very limited; it is only a reasonable solution for supplying individual institutions or farmhouses. Also, it cannot be highly effective because of the prevalent European climate (specifically, the lack of cool shoreline desert climates) and only a handful of pilot projects have thus far been implemented. Using sea water as a cooling medium (seawater greenhouse) can improve condensation and water extraction significantly. In this scenario, using solar energy to evaporate sea water increases water production. However, even such a solution is inadequate for supplying water to a whole settlement, even though it may be useful as an added local water source to meet overall demand.

8.3. WASTEWATER TREATMENT

Sewage treatment infrastructure is affected by climate change in three areas. The most direct impact of these is the effect of exceptionally intensive precipitation on the sewer system. Sewage storage reservoirs must also prepare both for large amount of water suddenly appearing in the system and for dry periods. Questions related to disposing of and utilising the sewage sludge and the treated water discharged from the treatment plant are already part of active mitigation and adaptation in the context of efforts to reduce greenhouse gas emission and in terms of water replenishment. Reducing the overall energy consumption of sewage treatment (in transportation and in the operation of the purification systems) and the transition to renewable energy also contribute to the reduction of greenhouse gas emission.

In the context of activities generating greenhouse gas emissions, sewage treatment is important because of its production of methane gas. Based on 2002 Hungarian data, with a 60% rate of canalisation, approximately 9,800 tons of gas from communal waste water and 6,300 tons from industrial waste water contributed to the national methane emission. In CO_2 equivalent, this is approximately half a percent of the total national greenhouse gas emission. However, its importance is much greater at settlement level as it is the third most important source of greenhouse gas emission after waste management and public transport among activities managed by municipal governments.

Older, combined **sewer systems** (sewage transport and precipitation draining) are the most exposed to the effects of high-intensity precipitation. Separate systems may be prepared for climate change using sustainable precipitation channel systems as a solution, while sewage treatment in this case is unaffected by climate change. Like in other areas of water management, the first step is **surveying the expected increased load** on the basis of a climate model. Based on the results yielded by the climate model, the system can be designed to specifications appropriate for the expected increased load. Then, based on the updated capacity rating, all the **necessary expansions and reinforcement measures** can be implemented. Growing amounts of precipitation also increase the dimensions and ratings required in the case of almost all elements of the precipitation drainage infrastructure. Changes in the load may vary from one area to another because of differences in the local climate, with calculated new loads exceeding historical water quantity values by 30 to 50%. Several modelling software packages are available for calculating system loads; however, the reliability of the climate models serving as the foundation of these software calculations are not yet fully satisfying in respect of any given settlement. For this reason, it is a good idea to envision several possible scenarios and then opt for the safest and still economical solution. At the same time, modelling and surveying facilitate identifying the weakest points of the network, something that also helps increase the safety of the environment.

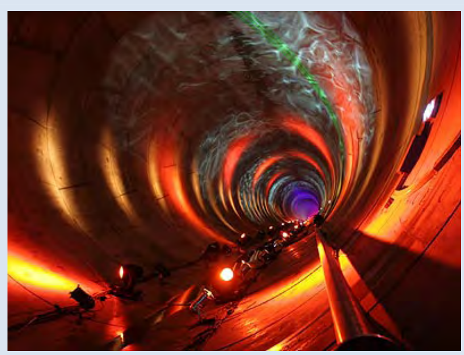
In city districts served by combined sewer systems (sewage transport and precipitation drainage) precipitation of unusual intensity or quantity does not only represent an increased load on the infrastructure. In fact, the sewer system may overflow and transport large amounts of polluted water into the reservoir, creating both flood protection and environmental problems. To prevent such a scenario, **retention basins** may be used. These should be constructed mostly at the terminal points of the sewer system, that is, as part of the sewage treatment plants. These are standard watertight pools used for storing the polluted water temporarily until the treatment plant is able to process the surplus. This solution is very simple, although it is relatively costly and it requires regular maintenance.

As wastewater normally only occupies a small portion, about 10%, of the total volume of the sewer system, precipitation water may also be stored temporarily within the sewer system itself. Implementing this requires **real-time control**. This system uses remote controlled sluices and pumps to enable the sewer system to actively manage the flow of water, ensuring that the flow direction and flow rate of water within the network can be controlled centrally. This requires the continuous observation and measurement of water quantities within the system and an appropriate algorhythm for controlling the system itself. A great advantage of the solution is that it can help avoid the need to build reservoirs; the total surplus water quantity of a downpour can be stored within the sewage network of a large city; and overflowing can be prevented, something that significantly improves the safety of the environment. Storage ensures that the sewage treatment plant itself receives regulated water quantities and thereby there is no compromise in the efficiency of purification. Currently, this represents the cutting edge in water control technology; as a result, only a handful of systems have so far been implemented.

Vienna, real-time control

Vienna, the capital of Austria has a population of approximately 1.7 million people.

Because of the city's climate, the number one problem for the city's sewage systems is managing the extraordinary outflows caused by unexpected high-intensity precipitation. In order to reduce the damage caused by the outflow, the city implemented a unified network in 2006 with the aim of preventing sewage, which is diluted by rainwater at times of extraordinary levels of precipitation, from surging back to the surface from the sewer system, thereby directly contaminating surface waters. Measuring 2,300 km in length, the sewer system has enough volume to temporarily retain excess water until it can be later discharged into the wastewater treatment plants.



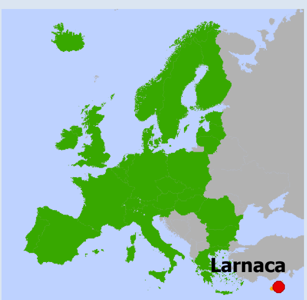
To implement such a system, the loading of the sewer system must be monitored continuously and water levels and flows must be controlled in a sophisticated manner. The amount of water expected to appear within the sewer system and the temporary storage capacity remaining available can be modelled on the basis of surface runoff data and meteorological data, also relying on continuously measuring water levels within the sewer system. The system consists of 25 precipitation and temperature metering stations as well as 40 flow metering and 20 water level metering stations within the sewer system, with the data generated by the network being processed by the Channel Information System (KANIS). The ideal scenario for storing excess water may be determined by processing real data in a simulated model, while interventions are executed through centrally controlled sluices and pump stations. Accordingly, the real innovation of the solution was the implementation of the monitoring, modelling and controlling system.

Since its completion, contaminated water has never surged back. Currently, the system has a usable storage capacity of 361,000 m^3, but additional development projects may expand this to achieve as much as 600,000 m^3, which makes the system a global number one. The control system is applied to the entire sewer system of the city; with a 98% canalisation index, this practically means the total population of the city. Construction work started in 2001; after test operation in 2004, the system was commissioned in 2006.

The development project was managed by the MA30 working group of the municipal government (Vienna Sewer Company). The total cost was EUR 9.3 million. The system generated significant international interest and in 2006 received the best practice award of UN Habitat.

Contact:
Mayor's Office, Vienna Sewer Company, Wastewater management
Phone: +43 1 79514 93094
E-mail: post@wkn.wien.gv.at

The preparation of **sewage treatment plants** for extreme weather conditions is especially important in the periods short of water. In case of the combined sewer system intense rains and intense rainwater can also be a problem; this can, however, be managed by inland water regulation and the establishment exploitation of the above storing capacities before the excess rainwater would reach the reservoir. The periods short in water may cause interruptions and defects in the ordinary course of water treatment as each treatment technology operates ideally only in case that there is a given degree of concentration, composition and quantity. In case of shortage of water or the increasing awareness of the population of the need to make economies of water, the sewage that is both more concentrated and more dense than expected. It is more difficult to treat or cannot be treated at all with the technology installed. Due to the smaller outflow than expected the contamination stays longer in the drainage network and, as a result, its decomposition can start in there, which may cause problems in the treatment plant. No special solutions are required for adaptation, the existing and widely known and used engineering solutions can be applied. The first step here is also modelling the expectable weather conditions and sewage quantity, based whereupon the predictable length and frequency of periods short of water can be projected with the effects of other measures aiming the making of economies of water, too. Based on these predictable changes the necessary sewage treatment capacities and solutions can be revised and the necessary projects completed. In case such is possible, the making of the technology more flexible can also greatly improve treatment efficiency in the critical periods.

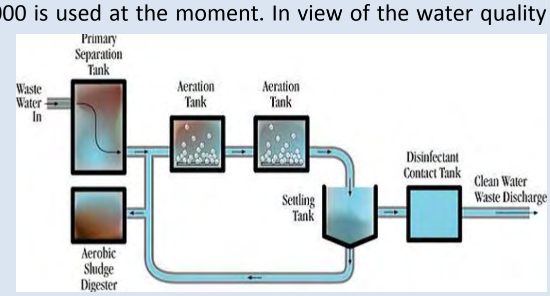


Larnaca, usage of sewage

Larnaca is a town in the Republic of Cyprus, on the South-Eastern bank of the island. Its population is approximately 70,000 people.

As a result of its climate and inadequate quantity of rainwater, a very deliberate water management policy had to be elaborated with the highest ratio of water recycling possible. According to data for 2007, only 3.5 per cent of the annual quantity of treated sewage (27.7 million m^3) was discharged into the sea, 9 per cent was led as supplement into the water bodies under the soil surface and 47 per cent was used for irrigation.

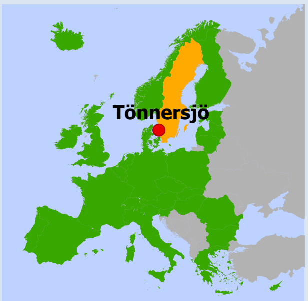
One of the most state-of-the-art of the significant sewage treatment plans operates in Larnaca. The plant has a capacity of 46,000 population equivalent of which 36,000 is used at the moment. In view of the water quality indispensable for re-use, treatment is of 3 stages. Following the completion of the second treatment phase water is sand filtered and then, chlorinated.



The plant annually treats and discharges 2 to 2.5 million m^3 water. The entire quantity is used for irrigation, mostly on the 250 ha arable land in the neighbouring village and in other gardens and green surfaces. No public health problem has been reported so far. In addition to recycled water sewage sludge is also used in agriculture in a quantity of approximately 5000 m^3 per annum.

EUR 9.3M corresponding to approximately 1/5th part of the total project cost was spent on setting up the conditions for the recycling of waste water, that is the construction of the stage 3 treatment facility, the pipe network and the pump station.

Contact:
Symboylio Apocheteyseon Larnakas (Larnaca Sewerage and Drainage Board)
Telephone/Fax: 24653924
E-mail: charoula.stavrou@lsdb.org.cy



Tönnersjö, use of sewage in a nursery garden

Tönnersjö is situated in Halmstad Municipality in the south-western part of Sweden and has a population of 126 people.

Due to the geological situation of the area, the nutrition value of the soil here is lower than in the more southern or continental European regions. Therefore, to supplement the nutrition value of soil is of utmost importance here. A sewage utilisation project was completed between 2002 and 2006. The sewage with high phosphor and nitrogen contents from the municipal sewage plant was led into and used in the nursery garden, the latter being a regular user of artificial fertilisers. In order to deliver the sewage treated in the local sewage treatment plant to the nursery garden, underground pipelines were used to avoid odours. Irrigation with this water had an unambiguously favourable impact: much more intense leaf and head development was observed. Thanks to this method of irrigation, the nursery garden made use of approximately 20 kg of phosphorus and 100 kg of nitrogen per annum, and it was also a considerable advantage that the demand for artificial fertilisers and irrigation water was reduced.

No unexpected or harmful environmental or health effect was experienced either on the surface or in the subsoil water. The most important lesson, however, was proper communication, involvement of all concerned, and the setting up of an organisation uniting all participants. The expensive underground pipeline, for example, was selected for this reason.

The initiative was supported by the programme launched by the Swedish government under the title ‘Subsidising Local Developments’ (*lokala investeringsprogram* - LIP). The subsidy was awarded in 2000. The total project cost was SEK 850,000 and the share of the subsidy within it SEK 319,000. As the development is simple, efficient and it serves the interests of the environment from several points of view (nutrients, recycling of water, economies in materials and energy) the project was classified as ‘Best Practice (BP), in LIP.

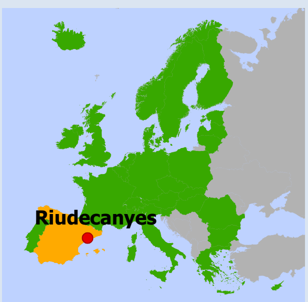
Contact:
Lars Olsson
Halmstad Municipality, Technical Department, Halmstad, Sweden
Phone: +46 35 13 80 35,
E-mail: lars.ohlsson@halmstad.se

The **composting of sewage** is a process similar to the composting of organic solid waste. With the appropriate method, nutrients suitable to be used in agriculture can be produced from it, whereby artificial fertiliser consumption in agriculture can be cut. Adaptation to the effects of climate change is also assisted in an indirect manner, although this source of compost is not that rich in nutrients as communal waste. For its composting, the sludge discharged by the waste water treatment plant has to be first dried, which can be done with the help of renewable energy, for example, solar energy. Here as well, methane and carbon dioxide are produced during composting. The collection and use of gases released from sewage sludge is already relatively widespread and has a well established technology. In addition to electric power or heat energy obtained from the gas produced in this way, the quantity of sewage sludge is also reduced and, thereby, the costs of sludge treatment, too. Expenses are an important factor also because half of the costs of sewage treatment comes from the treatment of sludge. Odours are reduced, and a valuable and marketable product is made.

8.4. TRANSFORMATION OF WASTE MANAGEMENT IN LIGHT OF CLIMATE PROTECTION

Waste management in itself is little affected by climatic changes. It has, on the other hand, a very important role in the mitigation climate change effects, especially concerning the disposal of the collected waste. In countries with highly developed infrastructures, landfill gas generated from the waste in landfills accounts for approximately 4 to 5, while in Hungary, to 20 per cent of all the emission of greenhouse gases calculated in carbon dioxide equivalent. The carbon dioxide emitted by waste incinerators should also be added, which means another 2.6 M tons. The exhaust gases released from waste collection should also be taken into account, although those represent a much smaller quantity.

Preventive measures are possible to realise also during waste collection, although the emission of greenhouse gases can be reduced only indirectly in this field. **Selective collection of waste** is a typical solution for this; its favourable impacts manifest through recycling and energy savings in the manufacturing sector. In fact, the selective collection services in themselves can result in increased carbon dioxide emissions due to increased transport needs; and the recycling of paper and various types of plastic does not necessarily lead to a decrease in greenhouse gas emissions. Compared to simple deposition, it is much more favourable; however, compared to incineration, it is not always a better solution strictly from the greenhouse gas emission respect because the energy consumed by transport and cleaning has to be also considered.



Riudecanyes, selective communal waste collection

Riudecanyes, Tona and Tiana are settlements in Catalonia, in the north-eastern part of Spain.

The three municipalities initiated the setting up of a selective waste collection system to mitigate the harmful effects of climate change and to encourage the active participation of their communities. The system has been operating since 2000 and by now it has 80 members.

The essence of the system is that the selective collection of waste takes place at the very points of waste production, that is, individually at the different flats and houses. The residents may collect their waste in containers of sizes similar to those of the regular waste containers. Such selective containers are placed in front of the houses, or in case of condominium apartment houses, in the common premises. The waste types collected selectively are: compostable organic waste, paper, glass, packing materials and non-recyclable waste. To organise the collection of metals, PET bottles, dangerous waste, and electronic waste would not mean any technical problem either.

Transport, selection and recycling are simpler and more efficient than in the usual way. Investment and maintenance costs are also lower as no special public collection containers or special transport vehicles are needed; besides, processing is also cheaper and quicker. There is no need for selective waste collection points either, and an additional advantage of arranging collection on this individual level is that it raises awareness and increases the sense of responsibility in the citizens; furthermore, they receive immediate feedback if they do not collect the waste in the way required.

With this system introduced, the ratio of waste collected selectively reaches 70 to 80 per cent in the participating municipalities, which is an outstandingly good result, especially if we take into consideration that this rate used to be 10 to 20 per cent before. The greenhouse gas emissions associated with waste treatment also decreased by 55 per cent in Riudecanyes. The costs of the programme were covered by the participating municipalities.

Contact:
Josep Maria Tost i Borràs, Mayor
Municipal Council of Riudecanyes, Spain
E-mail: aj.riudecanyes@riudecanyes.altanet.org
Phone: +34 977 834004,
Fax: +34 977834385
Web: www.portaaporta.cat

The use of hybrid collection vehicles to reduce the emission caused by waste transportation is not a widespread practice yet. However, it would be reasonable: taking into consideration the low speed, the number of repeated stops and starts and the fact that they work in a residential area, it would be ideal if the collection vehicles ran on electric power. This is a subject belonging to energy-conscious mitigation solutions in the field of public services, similarly to, for example, the modernisation of public transport. Supported by computerised **route planning,** the **transport routes and schedules as well as the transport capacities can be made optimal.** According to the experience so far, this may result in significant savings in fuel and, thereby in the costs, as well as cuts in greenhouse gas emissions. Savings can be realised at the border zones between the adjacent waste collecting areas, too, by harmonising transport tasks and by the co-operation between the different service providers.

From among the various methods of waste disposal, the less sustainable is, beyond doubt, the use of **landfills.** The same is true for the landfills regarding climate change as well. Even in the state-of-the-art landfills, anaerobe decomposition is the basis of all processes. As a result, the organic materials emit at a slow rate vast amounts of carbon dioxide (30 to 40% vol) and methane (40 to 55% vol) and, to a lesser degree, other gases. Under the conditions of the temperate climatic zone, following disposal, generation of the gas gradually increases for approximately half a year, and then, stabilised at the higher level, continues for even 20 to 25 years (E. Várkonyi, 2008). As the greenhouse effect of methane is approximately 23 times as much as that of carbon dioxide, such enormous amounts of it are critical from the point of view of climate change. Methane represents an increasingly precious energy resource, too; therefore, the **collection of landfill gas** is a must. This is of great importance especially if we take into consideration that by burning the methane content of the landfill gas, and thereby converting it by into carbon dioxide, the carbon dioxide equivalent of the emission of landfills can be reduced to its fifth. Collection and use of the landfill gas has to be an integral part of communal energy management, therefore, it is discussed in its technical details in the section about communal energy management.

Disposing of waste by incineration is a widespread method. It makes by the burning of gases generated by the landfills an opportunity for direct energy production, as opposed to the burning of landfill gases collected from the landfills. Generally, this energy is included in the figures of energy produced from biomass, although, due to the large quantities of plastic, a considerable part of it originates in fact, from fossil energy resources. Landfill gas, on the other hand, is generated rather from compostable waste. Due to the high proportion of non-combustible materials and water in the waste, incineration of waste is less efficient energetically than the burning of methane; also, the probability of emitting harmful substances is higher in the former case, too. Nevertheless, as increasing waste disposal into landfills is less and less possible, the only solution to dispose of the greatest part of communal waste is incineration. Consequently, this less advantageous solution is still widespread and has an important role. In Europe, due to its prevalence, this is the most important way to produce energy related to waste management.

Helsingborg, complex waste treatment

Helsingborg is situated in the southern part of Sweden, close to Denmark. Its population is about 95,500 people.

In an outskirt of Helsinborg, called Filborna there is a waste recycling facility including a biogas power plant that burns gases collected from the processed communal waste, sewage sludge and other organic materials, as well as a landfill site with a landfill gas collecting system.

The construction of the power station started in 1996. Waste is collected from the residential areas in special containers for each type of waste, and vehicles driven by biogas take them to the waste disposal facility. Here biogas is produced from the composted waste. Carbon dioxide and hydrogen-sulphide are extracted from the gas if it is to be used as fuel. The quantity of gas produced this way is enough to cover the regular fuel demand of 100 vehicles (buses, collection vans), while the rest is used to generate electricity or heat.

Because during the process special attention is paid to purifying the waste, the solid residue can be used as an organic fertiliser. It is delivered by a pipe network to the neighbouring lands saving thus 22,500 km of driving per year, which means also a decrease in carbon dioxide emissions by 40 tons. The power station has a waste processing capacity of 80,000 tons per year, and in 2001 it generated 12 000 MWh energy. The gas collection system, made in 1985, collects the gas emitted by the local landfill and, thus, this gas can be used for energy generation as well.

Contact:
NSR AB
Phone: +46 42-400 13 00
Fax: +46 42-15 37 73
E-mail: nsr@nsr.se
Web: www.nsr.se

The most ideal solution both in terms of the economy and the environment is **recycling and composting,** whereby greenhouse gas emissions could also be cut. Recycling has already a relatively well developed and established mechanism and it spreads gradually. Composting in the towns is solved only in the case of organic wastes of big volumes (fallen leaves, horticultural refuse, Christmas trees, food residue from restaurants, etc.). The recycling of packaging material contaminated with large amount of food remains from households (which, in principle, is compostable material) is not yet solved, and causes continuous problem for the incineration plants. Methane and carbon dioxide are generated also during composting and it would be worthwhile to collect these gases. The compost produced could efficiently reduce the artificial fertiliser uptake of agriculture or parks; and if green urban surfaces are more productive, this could also, although indirectly, contribute to the improvement of the microclimate. Another indirect advantage is that energy and water consumption and the use of chemicals can drop, and the adaptability of settlements to intense rainstorms and heat waves can improve.

A special side of climate change adaptation, which is related to environmental security, is the **safety of the existing landfills** and their resistance to changing environmental conditions. Existing landfills were insulated in ways that suited the environmental conditions which existed then, or as were seen adequate based on the knowledge existing at that time about future perspectives. As a result of the changes in the climate, erosion caused by rainwater may increase, and the changes in underground water levels may also result in mechanical changes and movements in the soil; consequently, the insulations of these landfills can get injured. The rise of the sea level may result in the rise of the underground water levels at landfills close to the sea, which is again a phenomenon that poses a sudden risk to insulation. The solution in every case is to survey and map the hazards, to prepare the necessary interventions, and to improve physical protection. The best solution would be the liquidation of landfills along with a widespread recycling of waste, but for the time being, this is still a very expensive solution that can be used only in particularly justified cases.

BRIEF RECOMMENDATIONS

- Urging water consciousness, surveying which elements of water consumption can be avoided.
- Use of alternate water resources, utilization of sewage.
- Elaboration and construction of sustainable urban water management and a sustainable urban drainage system (Sustainable Urban Drainage System – SUDS).
- Use of integrated flood prevention and bank protection solutions on the basis of integrated water management.
- Elaboraton of special plans for the coastal regions.
- Preparation of the drinking water supply system and the sewage treatment plants for extreme weather conditions.
- Transformation of waste management in a way that supports the aims of climate protection.
- Consideration of environmental safety under the changing environmental conditions also with a special care to water management and infrastructure.

9. PREPARING FOR DISASTER MANAGEMENT AND HEALTH CARE

Settlement management – like the prevention of climate change – has many tools available with which to best prepare the city, its buildings, infrastructure and above all its inhabitants for the expected and already unavoidable harmful consequences of climate change. It has to be stated that prevention and adaptation are not separable. Numerous measures that aid adaptation to the consequences of climate change, at the same time help prevent a further increase in climate change. In the long term, only those adaptation measures can be efficacious which also serve prevention. Preventive measures include: publishing information on expected threats and the possibility of adaptation; securing the required financial background (e.g. elaboration of financial incentives for building insulation and expansion of green spaces in both private and public areas); strengthening urban utilities' technical capacity and infrastructure network; the establishment of a settlement structure better adapted to the expected climatic extremities. One of the main issues of the present Handbook covers proposals for climate adaptation measures, within the competence of settlement management; these are described in detail in other chapters. Here, we are dealing only with the adaptation of the urban institutional network, health care management and 'extreme weather events' caused by the climate change, as the decisive majority of the European Union member states will most likely be affected by the expectable consequences of climate change and will be increasingly burdened by this.

9.1. LOCAL HEALTH CARE INSTITUTION SYSTEM

Climate change has numerous consequences which pose a threat to human health and life. These impacts are expected to become more frequent in the future. At the same time, we have to be aware that climate change is not a problem existing in itself, but was generated by the transformation and mal-use of the natural environment. Destruction of the natural environment jeopardizes human health due to many phenomena, and not all as generated directly by climate change. This has to be mentioned because by restoration and protection of the natural environment, not only health problems caused by climate change, but many other illnesses referred to today as 'civilisation-illnesses' can be eliminated, However, while this problem exists, the health risks caused by climate change are only strengthened by the other risks resulting from the destruction of the natural environment.

The problem of climate change has evolved from systemic flaws in how society works, thus the lasting elimination of related health problems is not (only) the task of the health care system, but the whole institutional system, which affects all aspects of society.

Health risks posed by climate change

The probably most well-known consequence of climate change which directly influences human health are heat waves, and the accompanying high levels of UV-B radiation. Research proves that, for example in Hungary, the rate of sudden inflictions and mortality increases by 15% on days when the daily mean temperature exceeds 25°C. According to forecasts, an increase in mortality can be expected in the coming years due to heat waves. Similar to this is another climatic phenomenon, where extremely hot weather suddenly evolves from extremely cold weather (without a heat wave). Like heat waves, this poses a danger especially to the elderly and those with heart problems, as such changes place a considerable burden on the human body. The reason UV-B radiation is stronger is primarily because of the thinning of ozone layer; however, this is connected to climate change because of the increase in the proportion of clear, cloudless days, namely in summer months, which also increases the amount of UV-B radiation reaching the Earth's surface.

A further consequence of heat waves can be the occurrence of forest or bush fires, which also endangers human health and life. As a consequence of climate change, more and more pests are appearing in certain areas that were not found there before. A possible consequence of this process may be, for example, the spread of ticks or mosquitoes and the illnesses they cause. Changes in flowering time and the spread of allergen plants are also connected with climate change. To respond adequately to the new threats posed by climate change, such as the increased presence of emerging viruses and undetected pathogens, and therefore to implement new existing pathogen reduction technologies that decrease known and undetected viruses and other pathogens transmitted by blood are of a high importance. As extreme events become more frequent, weather-related diseases and deaths might rise. Climate change can also increase the spread of serious infectious vector-borne transmissible diseases including zoonosis. Climate change will threaten animal well-being and can also impact plant health, favouring new or migrant harmful organisms, which could adversely affect trade in animals, plants and other deriving products.

A further consequence of climate change is the incidence of more frequent and stronger storms; this results in occasional injuries, or even casualties and involves further health risks, too (e.g. infection from polluted drinking water). A similar situation arises in the case of floods following heavy rainfall, especially when the flood recedes quickly.

Mitigation of health risks

One of the keys to reducing the health risks caused by climate change and the efficient management of the fore-mentioned natural 'disasters' is ensuring that local society, including the healthcare services, are prepared accordingly; this leads to as few casualties as possible. Preparation of the local healthcare system must be included in the climate strategy for the settlement; its most important elements must be included in the integrated urban development processes, if required. The necessity of the latter is determined by the analysis of the situation; the relevant consequences of climate change's risks to human health, in a given settlement, must be assessed.

Today's healthcare system is further jeopardized by other changes that are expected in the near future – in addition to climate change – such as the growing energy crisis. Although primarily related to the energy crisis, the malfunction or interruption of the **major social provision systems** (e.g. in case of heat waves and strong storms) is a possible consequence of climate change. Consequently, institutions need their own energy supply systems relying on renewable energy resources. Providing these not only serves to reduce the impact on the environment, but also provides a base for secure healthcare provision (energy supply malfunctions may cause huge problems especially for in-patient care). Measures such as this will have ever more importance in the future, especially in those big cities in which a number of medical care institutions are operating, which are also responsible for the care of other settlements. Of course, the ownership structure of the given medical care institution is also a significant factor, as is the proportion that is owned by local government.

Adaptation to health risks

The energy efficiency, energy- and water saving, usage of renewable energy, installation of green areas, self-ventilation etc. are elements of the adaptation to climate change for the **medical institutions**. **These elements can compensate the otherwise necessary but harmful measures.** For example, the usage of the needed air conditioning in buildings releases emission which intensifies the effects of climate change. A health building that was built adequately implementing the aforementioned elements can counterbalance the damaging effects of such measures.

Local food production, whether home-grown or from a small producer, can play a very important role in mitigation but also has a role to play in health care. Consumption of food originating from local or neighbouring small producers causes less environmental impact (therefore it is more advantageous from a climate change perspective) and is mostly healthier when compared to food produced by industrialised large farms. If possible, local medical institutions providing in-patient care should ensure the catering for patients either partially or entirely with food originating from local or neighbouring small producers.

Pressure on medical care institutions and transportation can be reduced if the population knows as much as possible about healing certain illnesses and complaints. In this instance, the assistance of local doctors and natural therapists may be called upon. Due to energy and economic crises, in the future there may be limitations to the scope of **medication supplies**; therefore various local, natural therapies may become increasingly better valued. Learning and application of **natural therapies** is essential, since their application needs less energy use and thus the environmental impact is also lower. A further advantage of these therapies is that they play a significant role in strengthening the relationship between nature and society, something that has been weakened nowadays. The popularity of natural therapies is continuously increasing throughout the entire European Union, and today more and more doctors and medical care institutions are already using these methods. The local government can contribute to the increase in climate awareness by – recognising the population's interest– organising courses to teach natural therapies, combined with other information about climate change. All these steps can contribute to an improvement in the health of the population – again, regardless of climate change – and it should not be affected by unexpected, extraordinary situations and, should a serious disturbance occur in the healthcare system, the population will not remain without medical assistance.

Awareness and communication

Beside expensive large investments, other possibilities are also available that enable the urban population to safeguard their health in extreme situations. Local medical care institutions and their employees can play a key role in this respect. An important step is **raising the population's awareness**, and providing an explanation of what action needs taken in certain actual circumstances (e.g. high UV-B radiation or heat waves). Besides personal counselling, it is useful to place advertisements and leaflets prepared by experts, for example, in waiting rooms. The local written and electronic press, as well as public forums, can also play a key role in passing on information regarding emergency situations and the modes for protection.

In extreme cases it may be important for the population to have basic **first-aid knowledge**, and are thus able to save lives in unexpected situations. An important step to achieve this objective is to include first-aid practice in local education, as well as local government courses, or even in the form of further or vocational training in work-places. Besides the local medical care institutions, initiatives like these can draw on the support of, for example, the local organisation of the Red Cross.

Besides informing the population, another important task is to provide **assistance in treating shock** following disaster situations and providing peace of mind. This is not necessarily the task of local government but it is much more effective if the local community can unite and help each other.

Due to the expected increase in the frequency of disaster situations, **communication** between local government, local disaster management institutions, local medical and social institutions, local training and educational institutions and the local population needs strengthened, in which the local press has a considerable role to play.

Paris, ‘Heat wave alert system’

Paris is one of the most populated metropolitan areas in Europe with its over 11 million inhabitants.

Summer 2003 brought to light the consequences of exceptionally long and abnormally intense heat-wave phenomenon and its impact on public health in France. The heat-wave between August 1 and 20, 2003 resulted in some 14,800 excess deaths in France, an increase of 55%. Paris was especially affected (an increase of 190%).

In 2003, 9 months after the catastrophic heat wave the City of Paris and the regional authorities have worked together out a plan to address and handle the impact of heat waves on the population. This plan includes the CHALEX register (abbreviation of ‘Chaleur Extrême’, extreme heat) that is a list of self-enrolled elderly and disabled people in the community. Those who consider themselves to be the most vulnerable are motivated via newsletters to register to the system (in 2010 19000 people have already registered). Thus the city administration can call them – using this list – on a regular basis during abnormally hot periods to verify their health status.

In case of any medical or other social irregularity the trained and authorised operators immediately call a sanitary unit located at the hospital that can alert emergency medical services (ambulance, fire brigade) to immediate intervention. They can also directly mobilise social workers if necessary.

On July 17th 2006 the National Weather Institute issued a heat-wave warning. Until July 28, the Social Services Agency called all the registered individuals every other day to check on them. Those who needed it were examined once again, by doctors who determine their health status. Nearly 800 elderly people were examined by a medical team during these 11 days; 200 were called back.


MAIRIE DE PARIS

BULLETIN D’INSCRIPTION 2009
pour bénéficier d’un contact en cas d’événements exceptionnels

ATTENTION ! Ecrivez lisiblement en majuscules

A remplir soit :
• par la personne âgée ou handicapée ;
• par son (sa) représentant(e) légal(e) ;
• par un(e) parent(e) ou un(e) ami(e).

Et à renvoyer à :
Mairie de Paris - DASES - CHALEX
125 bis, rue de Reuilly, 75012 Paris

Vous pouvez vous inscrire plus facilement et rapidement en téléphonant au 3975
(coût d’un appel local depuis un poste fixe sauf tarif propre à votre opérateur).

Identification du bénéficiaire

M. ☐ Mme ☐ Mlle ☐ Nom :

Année de naissance : Prénom :

IMPORTANT : précisez vos dates d’absences prévues en

Juin :

Juillet :

Août :

Personnes de votre entourage à prévenir :

1) Nom et Prénom :

2) Nom et Prénom :

Références du service médical, paramédical ou social ou en contact avec vous (médecin, kiné, aide ménagère,

Nom et Prénom :

Adresse :

Ville :

Most of the city’s interventions were limited to providing information on what to do and where to go during the heat wave. About 30 people were transported to air-conditioned adult day centres and 18 got urgent medical attention.

Contact:
Mairie de Paris - DASES - CHALEX
125 bis, rue de Reuilly, 75012 Paris
E-mail: service.presse@paris.fr
Web: www.paris.fr/viewPDFileServlet?file_id=64737

9.2. LOCAL DISASTER MANAGEMENT

Extreme weather situations such as heat-waves, sudden and heavy precipitation, big storms, hail, etc., may occasionally result in disasters - unmanageable forest and bush fires, floods, and so on. During such events, damage or total destruction of buildings, flooding of basements or low-level apartments, uprooted trees and falling branches, or damage to vehicles may incur, jeopardizing human lives. Besides this, infrastructural damage can constitute a risk to the surrounding areas not directly affected by the disaster e.g. in the case of power failure.

In the future we may count upon the increased frequency and strength of extreme weather situations, and consequently the number of disaster situations may increase.

9.2.1. Civil defence authorities

In the future the concerned institutes will have to be prepared as well that the frequency of extreme weather patterns will probably grow. To be prepared for the most extreme case health monitoring networks should be established in the co-operation of health sector together with non-profit organisations. These would continuously follow the health condition of dwellers belonging to vulnerable social groups, whether through daily phone contact or – in ideal case – personally.

Urban disaster relief and management are fundamentally more difficult due to the features of the site, and require special preparation (e.g. flood protection, control of fires). It is a special challenge despite the fact that rescue services can reach affected urban sites earlier. Accordingly, **local disaster management** needs strengthening in urban areas. This may be achieved by strengthening local agencies responsible for disaster management (by technical-technological development, improved equipment or increase in staff) and by involving local residents as volunteers. It may prove necessary for disaster management organisations to develop new tactics in which the threat of fire, water and storm damage receives more emphasis than it has until now.

Besides dealing with the emergency situation itself, actual **disaster prevention** is an essential aspect of protection against climate change-related natural disasters; both the natural and built environment offer opportunities for this. Settlements can take many such measures within their own administrative area, by which the natural environment can be made more resistant to extreme weather events. An increasingly efficient tool to protect against these events and their consequences is planting trees and woodlands in peri-urban areas and if possible, within the city. Forest areas not only mitigate heat waves, but on hilly-mountainous surfaces play an important role in preventing landslides following heavy rain, and in controlling sudden, heavy run-off from the hill-sides.

Analysis of previous, weather-related local disasters can be a great help in preparing local disaster management organisations. Such events generally caught the community by surprise. As there events are so rare, the lessons which could be learnt have, in most cases, not been learnt – precisely because of their infrequency. However, with accelerating climate change a new situation has evolved. In many instances records which have held for centuries fall year after year, and other weather situations are occurring, which were thought to happen only once a century. Therefore, collecting the lessons of the past may greatly help prepare and protect against those disasters expected in the future.

The main objectives of climate-health prevention strategies are the inventory of diseases, the identification of their characteristics, as well as that the stakeholders take preventive measures. It is necessary to increase the weight of the prevention as opposed to the number of actual interventions, medical care or rehabilitation. However it requires the increase of resilience of health and social systems in order to follow the health impacts of climate change, the situation of the epidemiology and of the contagious diseases as well as the effects of extreme events, the preparation of disease surveillance and monitoring systems is an important requirement.
Preparation for disaster situations may be included in the **local education system** – perhaps along with first-aid tuition and basic health care knowledge, as proposed in the previous section. Local disaster management specialists can be called on to help. Awareness can be raised by organising, for example, fire-fighting competitions and obstacle-races for school-children. Besides school-children, the adult population must also be prepared through ongoing training and further education opportunities.

Shaping the riverbed of small streams crossing through urban areas and establishing emergency flood reservoirs decrease the risk of floods due to sudden rainfall. It is also important to prevent disaster situations by increasing the use of drainage and vegetation. These interventions are useful in both natural and urban environments (buildings, linear infrastructure), and help mitigate or eliminate climate change-related extreme weather events. Although such interventions are rather expensive in the short term, they are beneficial in the long term, since this avoids the potential costs of disaster management and protection; however, these impacts not only have a monetary value, as stress, injuries, and casualties may be prevented.

In general, environmental safety affects all members and levels of society. All adaptation solutions should make an effort to maintain and increase this as we prepare for new and continuously changing environmental conditions. The state or the local government can only partially cover the relevant costs, therefore widespread property insurance is necessary. This will cause differences in wealth to become strikingly clear, even to increase to a certain extent, simply because the people most in need will have fewer possibilities to prevent damage. That is why to assess the impacts of climate change and adaptation policies on employment and on the welfare of vulnerable social groups is of a high importance.

9.2.2. Health sector management for the extreme weather events

Health systems are vulnerable to extreme climatic events. Extraordinary situations due to climate change may incur primarily on the effect of extreme weather events. Most public health measures and systems are already in place but they need to be tuned to the new situation and demand. For these cases the **institutes of the health authorities** have to dispose of such plans that record the order of the necessary measures in case of the actual situation. Such cases may be e.g. ordering the distribution of protective drink during heat waves (e.g. in frequented traffic junctions, railway stations, etc.) or ordering disinfection subsequent to floods.
The White Paper (Adapting to climate change: Towards a European framework for action), the European Environment and Health Action Plan 2004-2010 and the EU Health Programme outline what the European Union can do to address these potential challenges. The European Parliament has called for enhanced multi-agency co-operation in order to boost the early warning system and thus to curb the harmful effects which climate change has on health.

Indeed, climate change might have an impact on health systems by increasing the demand for health services beyond the capacities of those systems. It may also interfere with their ability to cope with demand by undermining infrastructure, technology and the availability of workforce. This is linked to emergency preparedness and response.

The Health Security Committee (HSC) was set up by the Council as an informal committee to address preparedness for and responses to major health threats, such as CBRN events or pandemic influenza. It focuses on three areas, each assisted by a section consisting of representatives of the Member States. These areas are:

- generic preparedness and response for public health emergencies;
- response to chemical, biological and radionuclear (CBRN) attacks;
- influenza preparedness and response.

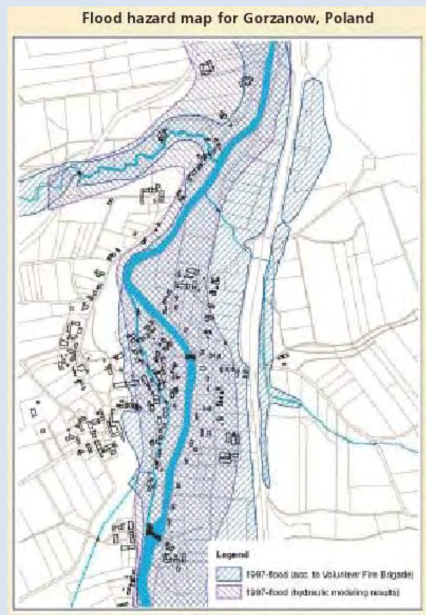
The JRC (Commission Joint Research Centre) supports the European Environment and Health Action Plan by providing the scientifically based information needed to help the EU and the Member States reduce adverse health impacts from environmental factors. In relation to climate change and health, the JRC was involved in the GAPCC (Global Air Pollution and Climate Change) Action contributing to scientific research on the linkages between air pollution and climate change, so that policy makers were made aware of the potential synergies and trade-offs in which the atmosphere and the climate system work. This action includes: the European Flood Alert System (EFAS), developed within the Weather Driven Natural Hazard (WDNH) project, which seeks to provide medium-range flood simulations across Europe with a lead-time of between 3 and 10 days, and which will provide information for the preparation and management of aid during a flood crisis; and the European Forest Fire Information System (EFFIS), which supports the services in charge of the protecting forests against fires in the EU and neighbouring countries, and which also provides information about forest fires in Europe.

The EU Health Programme supports projects and actions to improve health information and knowledge for the development of environmental health information systems. For example EuroHEAT which deals with actions at different levels: from health system preparedness coordinated with meteorological early warning systems to timely public and medical advice and improvement to housing and urban planning.

Gorzanów, flood mitigation plan

Gorzanów is a settlement in the south-west of Poland, near the Czech border, with a population of approximately 1,000 people.

Floods cause serious problems for the settlement. At the time of the 1997 flood, 81 homes and 100 farm houses were damaged, and 300 people had to be temporarily evacuated. Agricultural areas and roads were covered by water. The flood destroyed two bridges and damaged another two. The total damage amounted to 3.6 million EUR. A group was set up in 1997 in co-operation with the residents, to provide flood protection, coordinate flood preparation work and to perform other flood-related tasks.



The planning group includes teachers, volunteer fire-fighters, members of the Friends of Gorzanów Association, and local citizens. As a result of the group's activities, the following steps have been taken:

- a local flood warning organisation, operated by volunteers, has been set up;
- a questionnaire-based survey has identified to what extent the inhabitants were aware of their exposure to floods;
- the areas threatened by flooding have been surveyed and mapped;
- an emergency action plan has been created;
- educational activities have been carried out with the involvement of the local school and non-governmental organisation.

The members of the flood warning organisation are mostly local volunteer fire-fighters. Their task is to alert residents and to keep a regularly updated register of their telephone numbers. They also distribute informative flyers and offer advice to locals about how they can protect their assets should there be a flood. The action plan elaborated for flood emergency situations aims to secure the safety of the inhabitants within the shortest possible time. The plan includes an evacuation centre for humans (this is set up in the local school) and also one for livestock (this is designated in a flood-safe area) and also identifies evacuation routes. The municipal government provided funding for thE programme.

Contact:
Roman Konieczny
Institute of Meteorology and Water Affairs
E-mail: roman.konieczny@imgw.pl

BRIEF RECOMMENDATIONS

- Assessment of climate change impacts on human health.
- Preparation of health care system for related health risks.
- Reinforcing capacity to develop the modelling of health effects as a function of extreme weather and obtaining the data to define the needs for improved forecasting heat waves.
- Developing national, regional and local adaptation action plans to address the health impacts of the extreme weather situations and which will need to be integrated into the preparedness planning of health authorities and services in order to help assess their health-related vulnerabilities to climate change and develop health-related adaptation strategies.
- Reinforcement of public health policies and training, including effective surveillance and emergency response systems, and sustainable prevention and control programmes.
- Informing and preparing the local population for emergency situations and defensive measures.
- Raising awareness of local population.
- Development of guidance on surveillance, which will have to be matched by support for implementation and capacity development, such as microbiological support for food hazards detection and entomological knowledge and capacity.
- Disaster prevention interventions in the natural and built environment.
- Strengthening of organisations and institutions involved in health sector and disaster management.
- Improving the communication between the local governments, institutions, disaster management, health, social, and educational institutions and local residents.
- Further efforts towards identifying efficient health measures and public health response, including the strengthening of emergency medical services, early warning, education and outreach to vulnerable population groups, and better accessibility to key determinants of health, such as clean water, energy and sanitation.

10. CREATION OF CLIMATE-CONSCIOUS ATTITUDE AND LIFESTYLE

In addition to prevention and adaptation, the third element in the fight against climate change is strengthening climate-conscious attitude. Behind the environmental crisis, which is a result of a dysfunctional system structure, stands the inadequate operation of the socio-economic system. Being that increased consumption is the basic principle of operation of the society and the economy, its reduction would significantly menace the basic operation of the system. The reduction of the environmental burdens, and thus the fight against climate change can be successful with the reduction of consumption and the creation of a socio-economic system which differs completely from the existing one. In order to achieve this goal, the attitude of society has to change radically. We need a new climate and environment friendly society that is aware to not exceed a certain limit of consumption.

Having climate conscious individuals is not enough, climate conscious communities have to provide support for them. An important element of the present socio-economic structure is that it is too individualistic. The mainstream attitude of 'Create yourself' is most important and, as a consequence, people pay less attention to each other and their environment. In order to strengthen the climate conscious attitude and to change the present incompetent structure, the reorganisation of local small communities is very important. May it be prevention or adaptation, on a local community level it is more efficient to fight against climate change than on the individual level (may the individual be obliged for the case). With the restoration and support of local small communities, we should create a society that has less of a burden on the environment, and put emphasis, not on the satisfaction of individual consumption needs, but rather on paying attention to and caring for each other and create an environment that can finally play a role in reducing the climate change.

10.1. STRENGTHENING CLIMATE CONSCIOUS ATTITUDE

10.1.1. The significance of changing the values of the society

The change of the values is essential in making the first step to creating an environment and climate conscious behaviour both on an individual and societal level. The change of the values of the society is a basic necessity to change the present socio-economic system which encourages even more consumption. No society can become sustainable without cutting back on the role of consumption.

More and more research shows that the more value placed on money and on material consumption along with all the status and formalities connected to it, the less attention is paid to improve the environment or climate conscious behaviour. Materialistic and selfish interests contribute to climate change. While following such internal values, such as helping others and finding roles in the community, are connected to sustainable, more climate conscious behavioural patterns. In the Western societies, as in Europe the concept of the well being and happiness is too closely connected to the level of consumption. In order to change the values we have to interpret such basic definitions again, as ‘development’ and ‘developed’, ‘economy’ and ‘poverty’ or ‘modern’ and ‘traditional’. This could also help to provide answers for the proper questions. During the fight against the climate change, in many cases the problem is not that we give poor answers to the questions raised, but rather the questions themselves are bad. There are questions raised even more often: How to cover the present energy need of the society? From what kind of renewable source? And, at the same time we don’t even raise the question whether society really needs that much energy? (Obviously not).

Connected to the change of attitude, one of the most important ideas has to be that society is not entitled to the amount of natural resources consumed at the present time. Tim Kasser, professor of psychology, in his publication entitled the *‘Structure of the World’* in 2009 states the following: ‘Our world is (….) sick, however it is not burning, it is getting warmer in a dangerous speed. The more problems we have, the humanity will be before a crossroad: shall it continue its life as earlier (…), or it ‘wakes up’, and realizes, that only the crazy ones keep to the damaging lifestyle, and use the threatening environment changes to change the priorities and values.’ (T. Kasser, 2009)

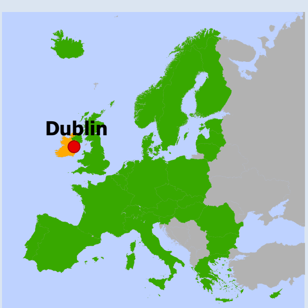
The creation of local and climate conscious values have two significant outcomes. One - the lifestyle of the local resident is less harmful for the environment. Second - in case these people understand the connection of change of the climate and they become aware of its dangers. When this occurs, they will likely accept decisions more readily, and proceed to give up something or harm their short term interests. For example, the radical reduction of local car transport is difficult to implement in a city where residents are not aware of car pollution’s long-term effects.

10.1.2. Possibilities to raise the climate consciousness of the society

Behind the values of the society there is a rather strong economic interest, however we still own such measures that may positively influence the thinking of humans. In order to change our values, and as a result our lifestyle, we have several possibilities we can implement everyday as well.

One of the most important steps enforcing the climate consciousness of the local society is if we introduce climate conscious values to **local education and training institutions**. This, on the one hand, may happen through the introduction of climate change topics into education material (workshops, sessions, organization of excursions, etc.), and on the other hand, in everyday practice, when the environment and climate conscious attitude emerges in everyday life of the institution.

The practice carried on in the education and training institutions may prevail in **workplaces and institutions** as well. On the one hand, it can be done in a way that the campaigns popularizing climate consciousness is integrated into the training. On the other hand, as in the case of the education and training institution, we can teach environment and climate conscious behaviour in the everyday practice as well. An example for this occurs when comparing the average use of electricity (we do not use air conditioning equipment, during the daytime we do not use lighting, and we switch off the unused computers, etc.), we collect garbage separately, we use recycled material, etc. These qualify on a grand scale as small steps, but slowly these may help to create the climate conscious attitude.



Ireland- Green-Schools Programme, An Taisce

The current population of Ireland is approximately 4.1 million. The number of students in primary education (2009/2010) is 505,998 and the number of students in secondary education (2009/2010) is 350,687.

Green-Schools (www.greenschoolsireland.org) is an international environmental education programme developed by the Foundation of Environmental Education (www.fee-international.org) and operated in Ireland by An Taisce (www.antaisce.org). Green-Schools is a long-term thematic programme and award scheme that aims to make environmental awareness and action an intrinsic part of the life and ethos of a school.

This is achieved by implementing the 7 step process outlined below:

1. Green-Schools Committee: This is primarily made up of students, teachers, parents, management, non-teaching staff and members of the wider community.
2. Environmental Review: This is the process of examining the school's environmental impacts (e.g. how students travel to school) in order to identify targets for action and improvement.
3. Action Plan: This gives specific and achievable targets, based on the findings of the environmental review, with proposed completion dates that will show real success.
4. Monitoring and Evaluation: This will ensure that progress towards targets is checked and amendments made where necessary.
5. Curriculum Work: This will integrate the Green-Schools programme with the curriculum work of the school when and where possible.
6. Informing & Involving the Wider Community: This will spread the Green-Schools message throughout the whole school and wider community through ongoing publicity and a 'Day of Action'.
7. Green Code: This aims to state the objectives that demonstrate the schools commitment to environmentally friendly actions (e.g. 'Use your feet, it's really neat!' 'Come on people, use your head, don't drive to school- walk instead!').

The Travel theme of the Green-Schools programme (other themes include Litter and Waste, Energy, Water, Biodiversity, Climate Change and Citizenship) was launched nationally in 2008 with the support of the Department of Transport and the National Transport Authority. Approximately 650 schools have worked on the Travel theme to date. The theme aims to promote sustainable travel (cycling, walking, park-n-stride, carpooling and public transport) to and from school and to raise awareness of the effects of transport on the environment.

Students, teachers, parents, An Taisce, Local Authorities and other organisations outside the school are involved in the planning and implementation of their School Travel Action Plan, promoting the formation of strong bonds within the community. Through initiatives such as cycle training, COW (Cycle on Wednesday) days, walking buses and WOW (Walk on Wednesday) days, students and teachers are encouraged to adopt a more sustainable approach to making journeys. Results from schools that undertook the programme between 2008 & 2010 indicate that over the past two years participating schools experienced a 27% reduction in private car use to more sustainable modes of travel to school. This represents over 11,800 people per day making the switch from the private car to sustainable modes of transport such as walking, cycling and park n stride.

The Green-Schools programme is operated in partnership with Local Authorities, and funded by the Department of Transport, Repak Ltd, ESB Independent Energy, The Wrigley Company and the Department of the Environment, Heritage and Local Government.
Contact:
Green-Schools Office, An Taisce
E-mail: greenschools@antaisce.org
Web: www.greenschoolsireland.org

In order to accept and support the measures taken as a consequence of the climate change and to prepare the population, the **availability of environmental and related policy information** has to be ensured as widely as possible. The **communication** between the decision makers and the members of the community is elementary.

An additional step in strengthening climate conscious attitude can be the organization of different **campaigns**. During these, on the one hand, the people have to be informed about the situation created due to the climate change and the expected future consequences. Furthermore, practical and everyday solutions have to be presented. According to the experiences, people can easily make steps for a cause and if they are aware, why those steps are necessary. It is important that the advertisements of the campaign promoting this climate conscious behaviour show information of the possible consequences of following or neglecting these behaviours. There are several ways to execute these campaigns: organization of presentations, forums, public showing of films in connection with the climate change, games, family programs, demonstrations (e.g. bicycle processions). These campaigns may take place in different education and training institutions, workplaces, offices, community centres, and different open air spaces.

Florence, R.A.C.E.S. campaign for climate consciousness

Florence (approximately 365.000 inhabitants, Trento (approximately 112.000 inhabitants, Modena (approximately 180.000 inhabitants), Bari (approximately 328.000 inhabitants) and Potenza (approximately 68.000 inhabitants) are cities of Italy.

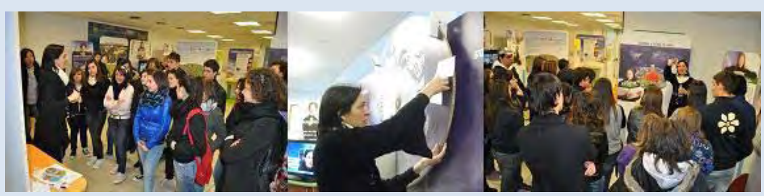
The five cities participate in a project from January 2009 till March 2011 (R.A.C.E.S. – Raising Awareness on Climate and Energy Saving). The main target of this project is to call the attention of the climate and the energy saving. The sub targets are as follows:

- draw the attention of the families, teachers and local organizations living in the neighbourhood of the city to the effects of the climate change;
- support and implement the environment consciousness into the lifestyle of the residents, especially the families;
- assist the local environment organizations and integrate the concerned ones to the program, so that they can represent their own interests, and share their different type of experiences and suggestions in connection with the prevention and adaptation.

As a preparation of the action plan, with the assistance of investigations the present knowledge and information of the people in connection with the climate was estimated. Further emphasis was laid on the information of the teachers regarding the assisting educational material in connection with the climate. Especially big emphasis was laid on the climate conscious education of the younger generations – beside the special education additional material the educational materials contains more and more material regarding the topic of the environment, and the change of the climate, e.g. as introductory experiments.

In the project exhibitions and organizations in the topic of the climate change were organized, where the residents can gain even more information. The energy consumption of the families chosen previously is estimated, further they are provided with an 'environment-friendly package'. For the first time external advisors help them, later they have to estimate the carbon-dioxide emission themselves. In the end of the six month period the organizers again count the carbon dioxide emission of the household, and the household having the highest performance receive a gift in connection with the energy and cost efficiency of the household. Following the different programs the experiences are uploaded on the Europe Direct network, so that other cities shall also be able to adopt the project.
The project is part of the project of the European Union called LIFE, it's total budget is 1.032.682 EUR, 49.47% (509.631 EUR) was co-financed by the Union.

Contact:
Natale Seremia
Telephone: 0039 055 2616795
E-mail: seremia@comune.fi.it
Web: www.liferaces.eu



Local transportation may be an excellent field for forming the climate conscious attitude of the community. There are several means to popularise local transportation, bicycle riding and walking. One of these often used means is drawing attention (e.g. organization of car-free days, bicycle events), the other is showing direct example. The latter is one of the most effective measures of popularizing the climate conscious behaviours. This is especially true when leaders of the local community and other respected persons or families show a good example. The example is more effective when it comes from somebody whose opinion and acts is more noticed by people. The mayor of a big city, or the members of the board of representatives may go to work with public transportation, bicycle or on foot. This not only shows a climate conscious behaviour towards their environment, but they hold more credibility among their people. If other local respected people (e.g.

celebrities) show good examples, then this may also have a good effect. The local popular persons should be asked intentionally by the municipality so that they can popularize the climate conscious behaviour.

An example for the reduction of the emission of greenhouse gases on the local level

CO_2 Monitoring Tool for local authorities

There is an Internet-based software (ECORegionsmart, that was developed by a Swiss company, the Ecospeed), and through this device the German local administrative areas, authorities and cities are able to calculate their carbon-dioxide emission. The advantage of the software is that due to the standardized method the good management and the evaluation of the data it provides comparison between the emission of certain municipalities.

Access:
www.klimabuendnis.org/co2-monitoring0.html

Local retail also has a possibility to strengthen climate conscious attitude. The popularisation of the local products, leaving the packaging material, and the sale of environment friendly products are all such steps that may influence the attitude of local residents in a positive direction.

According to the opinion of certain psychologists, another possibility further increasing the climate conscious attitude are the **reduction of the promotions and campaigns persuading us to consume, and we should shut them out from our everyday life**. As a result of the promotions, material consumption is increasing and the load on the natural environment is growing as well. Furthermore, they transmit such values that say that the source of happiness is the even a larger amount of consumption. In certain Scandinavian countries that became aware of this, the promotions targeting the children were banned, and thus they managed to slightly stop the spread of consumption centred values (T. Kasser, 2009). These means are at the disposal of managers of the cities as well. The simplest situation is within the media maintained by the mayor's office (local printed media, radio, TV, Internet sites), since the management of the settlement may have a direct say on what kind of promotions and advertisements shall be published. Another possibility lies with the regulation, reduction of the boards, and signs to be found in the area of the settlement (in this regard the local building regulations may have a role). Part of the existing boards may be disassembled, or used for the popularization of an environment and climate conscious activity (e.g. free advertisement area should be provided for these). This may mean direct income loss for the municipalities, but the change of the attitude will be seen in the savings, and keeping the advertised climate conscious principles will strengthen the political credibility of the municipality.

The founding of various competitions or awards is very effective and can be implemented mostly with low costs. The organisation of competitions work among youngsters, especially among school children very well, out of which real tradition may evolve with related events. In case of awards, the activity of the local government or organisations is also important, but apart from these, in the most varied topics a number of international awards are widespread. Such an international recognition can mean serious honour for a large city, but smaller settlements can find such competitions, considering their possibilities, and they can apply with very good chances to succeed.

Examples of prizes for cities acting for preventing the harmful effects of climate change:

Climate Star Award

Award of the European Climate Alliance, awarded to the district, quarter, settlement, local organisation or local government for the best settlement climate protection programmes. In case of settlements there are 3 categories depending on the settlement size (over 100,000 inhabitants, between 10,000 and 100,000 inhabitants, up to 10,000 inhabitants). Apart from that, special awards may be given (e.g. in 2009 it was awarded to Vienna). The prize was first awarded in 2002 to a total of 19 cities, since then awards

Climate Alliance

were given anew in 2004, 2007 and 2009. During the last award ceremony, 11 cities received this title.

Contact:
www.klimabuendnis.org/451.html

European Green Capital
Initiative of the European Union that awards cities that are pioneers in establishing environmentally friendly urban life, make efforts to increase energy-efficiency, to reduce their carbon dioxide emission and to improve their environmental conditions with regard to sustainable development. The awarded cities as European Green Capitals are Stockholm for 2010, Hamburg for 2011, Vitoria-Gasteiz for 2012 and Nantes for 2013.

Contact:
ec.europa.eu/environment/europeangreencapital/index_en.htm

10.2. COMMUNITY SHAPING – CLIMATE-CONSCIOUS LOCAL COMMUNITIES

Climate-conscious approach and behavioural patterns can generate significant impact especially if they are embraced by a whole community and do not remain on an individual level. If the community is large enough, then the approach or behaviour dictated by the community may have an impact on wider layers of the local society. All this brings the necessity of establishing and developing climate-conscious communities, which then will take a role in strengthening prevention, adaptation and climate awareness.

Concerning adaptation, the local level holds great importance since local communities can react to nature's changes quicker and more flexibly. Reduction of natural resource supplies and the impacts of climate change affect local levels, as well, to which, in light of the local natural and social capabilities, in various areas different answers may be necessary. In the near future the operation of large supply systems can become even more insecure. At the same time local resources and supply based on them will have increasing importance. A further argument in favour of local-level initiatives is that solution of the locally occurring environmental problems cannot be efficient without knowing the local natural and social capabilities and the local habits.

One of the most important basic conditions of a sustainable society – sustainable nature-human relationship – is that if possible, communities should exploit the locally available resources, and vice versa, the locally available resources should be used by the local communities, thus being dependent on the large supply systems to the smallest possible extent. This is crucial due to several aspects: sustaining the large supply systems require a great amount of energy, the production of which brings along a significant environmental load which strongly contributes to climate change, on the other hand a society based on local resources can better see the limits of its own consumption than a society dependent on resources from farther geographical areas. Therefore the **supply systems based on local resources** can prove to be more efficient in the fight against climate change than the large supply systems. Furthermore, independence from large supply systems helps the enforcement of local interests against external interests and has a role in generating local job opportunities.

The strengthening of the local level is possible in the long run only if local communities are reinforced, as well. For communities to be created, individuals need common goals. In the present case, the common goal must be the reduction of climate change and the preparation for the already unavoidable consequences. In order to achieve that, the reduction of climate change and adaptation to the unavoidable consequences should become common goals. Individuals must become conscious of the danger posed by climate change. Reinforcing climate awareness is therefore a key task from the aspect of **community organisation**.

For widening the environment and climate awareness of the local community, it is worth to form such local groups in the communities that are dealing with the local challenges of climate change emphatically. Their topics correspond to those listed at shaping individual attitudes. This way e.g. cyclist, outdoor, energy-saving, etc. **movements** can be organised and communities can be created on the basis of these goals. When this happens, the attention of existing groups (e.g. local organisations) can be turned to climate awareness, which is held together by frequent (!) programs on the topic or other leisure activities.

In case of natural disasters, which are expected to occur even more frequently, quick reaction can be life-saving. However, well-organised **associations** will be necessary for this, for instance, the widespread voluntary fire-fighter associations. Based on this pattern and depending on the type of local threats, associations can be created like flood/inland water rescue associations, forest fire source vigilance network, associations which become active during heat waves, frequently visiting the vulnerable inhabitants and distributing cool drinks, etc. By organising other leisure activities, these associations strengthen community feeling, but at the same time provide protection for the inhabitants during the time of potential natural disasters. The foundation of these organisations can be proposed by the leaders of the settlements.

Beside non-governmental organizations, **local churches** may have a vast role in organising local communities. As climate change intensifies along with the environmental crisis in general, churches must take a larger role in the preparation of the local communities. This jointly relates to the mitigation of the environment and climate-damaging impact of people all the way to the adaptation to the already unavoidable consequences of climate change and the strengthening of climate awareness.

Another possibility for the development of local communities and local economy as well is to involve local or close-by food producers in the community, thereby facilitating the direct sale of their products to local consumers. The **local producing and consumer communities** formed in this way contribute to the reduction of environmental load and to the strengthening of climate awareness at the same time, furthermore, they support the reinforcement of local food producers and through this, the local self-sufficiency concerning food products, which all serve for adaptation.

The most efficient way bringing together local and close-by producers is to organise markets and fairs in the settlements. Various studies show that people talk ten times more in producers market, as well as greet each other ten times more and even establish friendships, than, for example, a large commercial centre (Halweil – Nierenberg, 2007*)*. It may help if the opening hours of these markets are adjusted to the needs of the local people. They should not only be open during the 'traditional' market times (in the mornings and on weekdays), but during the late afternoon hours and on weekends. This serves the enforcement of the local community interests even more, if the markets provide opportunities only for the local and close-by producers. Similarly – beyond the reinforcement of prevention, adaption and climate awareness – the organisation of various exchange clubs or flea markets can also support in the strengthening of the local community.

An excellent tool for local community development can be restarting traditional **assistance systems based on favours** (so-called 'bees') or any other kinds of organised volunteer actions within the community. The 'bees' used to be an important institution for maintaining the local communities, which – beyond giving the feeling of community togetherness to people – was a crucial pillar of the autonomy of local communities and their independence from the external world. Extreme weather conditions caused by climate change and the ever intensifying global resource crisis may generate such situations in the future that can cause the operational disfunctioning of large supply systems. Reduction of the dependence level of settlements from the large supply system is therefore of key importance to the smooth operation of the local society. Water, food, and energy supply are the scopes on which it would be primarily necessary that settlements depend less on the large external supply systems. Organisation of 'bees' can extend beyond helping each other to activities serving public interests, such as planting trees, landscaping of trees, squares, etc.

A measure promoting climate-conscious attitude, adaptation and – through the reduction of energy consumption for transport purposes – mitigation of climate change is establishing **community gardens** on a part of the settlement's green areas or empty plots. Such gardens provide an opportunity for city dwellers to spend their time with a useful and creative activity. While people get closer to nature, they produce part of their own food and thereby reduce their dependence on large supply systems.

Finally, we have to mention that **settlement climate programmes** can also contribute to the strengthening of local communities. In this case, it works vice-versa. Strengthening communities support the execution of climate programmes, and also the execution of climate programmes may bring together the local people, thereby strengthening the local community. Similar actions can be integrated into environmental programmes for settlements. Based on experiences gained so far, the implementation of programmes promotes the reinforcement of local communities.

BRIEF RECOMMENDATIONS

- Changing social values: supporting the small community instead of individualism.
- Supporting energy-efficiency in addition to supporting the use of alternative sources of energy.
- Introduction of climate-conscious approach in local education and training institutions.
- Making local retailers more climate-conscious (e.g. sale of local goods, using environmentally friendly packaging materials).
- Organising local transport programmes (e.g. car-free day).
- Engaging honoured persons for the promotion of programmes.
- Organising campaigns stressing a climate-conscious social attitude.
- Transformation of local media; replacement of advertisements prompting consumption for those reinforcing environmental consciousness.
- Promoting the utilization of local resources.
- Strengthening of local communities for the sake of a common goal (preventing climate change).
- Promoting local/close-by producers.
- Supporting churches in preparing local communities.

11. SUPPORTING DEPRIVED GROUPS IN ADAPTING TO CLIMATE CHANGE

To various extents, climate change in European cities affects everyone. It is common that anomalies originating from climate changes and the resulting unpredictable weather patterns affect disadvantaged people stronger. Greater exposure and limited possibilities for preparation jointly raise the level of vulnerability and illustrate the importance of paying special attention to deprived groups with regard to their preparedness for climate change.

It is theorised that climate exposure further worsens the socio-economic position of deprived groups. Nevertheless, beyond this opinion it can be observed that the privileged and better off stratum are more active with the consumption that is responsible for the processes which generate climate change (e.g. due to larger ecological footprint). However, because of their exposure, the resulting processes and impacts generated from climate change hit poorer people living under disadvantaged positions harder. In other words, **those who suffer worse from the processes are triggers to a lesser extent**. This points all the more to the fact that the deprived group's situation requires more attention with their adaptation to climate changes.

The recognition of this fact provides an answer to the question – why is it necessary to support investments from community sources generating financial benefits (e.g. value increasing effect of insulating a home) in favour of persons not looking after themselves and their possessions (e.g. in the form of insurance)? It is important to be aware that facilitating the adaptation of deprived social groups to climate change – e.g. through insulation of buildings, increasing climate awareness – will contribute to the decrease of green house gas emissions throughout the whole city, therefore mitigating the effects of climate change. Community resources used for this purpose thus serve community goals, as well.

It is important to determine which groups can be regarded as deprived as it pertains to the effects of climate change. It modulates the definition that the present issue concerns mainly urban problems and urban inhabitants, therefore the poverty problem of rural areas is not affected. Considering all the above, we recommend defining the following urban social groups as deprived with respect to climate change:

– people living in poverty (international definitions exist in this topic, with special regard to the three types of poverty definitions of the recently approved EU 2020 document);
– minority groups – mainly due to the lack of information resulting from isolated community life, mostly secluded from the majority society;
– people with disabilities.

From the aspect of climate change, the most important characteristic of the deprived people's situation is **poverty**. All other accompanying circumstances (lack of financial means, segregated residential conditions, problem with access to public utilities, low education level) are secondary. The higher than average exposure of disabled people is relevant, since they cannot adapt fast enough due to their physical or mental limitations, moreover to absorb the consequences of climate change (especially if these occur suddenly), and defend themselves.

The deprived group's situation can be a one-off phenomenon, for instance when people of poorer status live in a richer status area. In this case, the focused solutions must be aimed at persons and families with problems.

The deprived group's situation can be an individual or a mass phenomenon. This is observed through the inhabitants of **city ghettos**, **slums**, neighbourhoods of immigrants, and transitional dwellings of those with a migrating lifestyle. In these cases the solutions should not be focused on certain people or families, but should be organised on a territorial basis. The deprived group's situation should be regarded as a mass phenomenon and having a territorial projection is more characteristic of urban living than of rural areas. Due to the large populations who live in narrow spaces, certain climate effects (e.g. heat wave) can be felt more than under non-urban conditions.

An important task is to define exactly which unfavourable effects of climate change the various deprived groups are more vulnerable and more exposed to. Correspondence with the various criteria of the deprived group's situation means that the members of these groups have some kind of physical, mental or financial deficit. This means exposure already in itself, the lack of chances of making changes from their own resources. The deprived group's situation as a factor of vulnerability can be examined from several aspects:

– Vulnerability related to housing: Based on **poor housing conditions** (e.g. constructions on flood plains, general congestion, lack of green surfaces, greater exposure due to the complete lack of energy efficiency), which both, derives from the deprived group's situation and also further generates it.
– The basis of vulnerability due to the **lack of financial reserves**: The affected persons do not have any proper means for neither adapting to climatic changes, nor for mitigating the impacts and damages of the events occurred. Therefore, due to the lack of financial resources, they have a high chance of becoming victims of damages caused by the unpredictable weather phenomena.
– Vulnerability owing to the **lack of information**: Reducing the capability to adapt, since language and cultural problems or the lack of access to important information concerning the issue makes this stratum unprotected and defenceless.
– The joint presence of the vulnerability factors listed above often occurs, i.e. climate changes and their impacts may affect deprived groups from multiple aspects under urban conditions.

In the following, the intervention possibilities are presented classified according to the main areas of the climate change. The help of the town management can and must prepare the deprived groups to the expected climate changes and their consequences.

11.1. FACTORS RELATED TO WATER AND THE LACK OF WATER, IMPACTS AND ACTIONS

Climatic consequences related to water can be regarded as the most intensive impact trigger factor. This can be subdivided into predictable processes (e.g. rising of the level of sea water due to the melting of the ice caps) and abrupt changes (e.g. floods). The following main water related climatic impacts which affect the deprived groups are to be separated as well.

– Rising sea level – melting of ice caps (effect of higher sea level on coastal cities, lower areas, etc.).
– Sudden downpours, hail, floods, inland waters (vulnerability of buildings and residential areas exposed to these events, even located in flood areas and destruction of urban green spaces).
– Drought (devastation of green areas due to aridity, vulnerability of drinking water supply).

The possible areas of community intervention may be the following:

– **Territorial intervention**, e.g. denial of building permits to certain locations, removal of endangered buildings, relocation of endangered inhabitants and the community financing of these efforts.

– Establishment of a **risk management fund** that intervenes on the level of the endangered family (or individual), e.g. support for moving, reconstruction, damage prevention.
– Taking preventive and comprehensive measures through which adequate **preparation** can be ensured for dangerous situations. The basis of these measures is communication, which can be an effective tool in creating awareness and ensuring the preparation of both, the community and the individuals.
– Taking out **insurance**, supported either through a group or a community level, for the mitigation of potential damages. Community support when negotiating with insurance companies since they often do not want to insure buildings located in potentially dangerous areas.

The **rise in food prices** and the consequent relative shortage of food affects especially the disadvantaged groups. In Europe, despite the climate change, no problems are expected in the sufficient provision of food. However, in the era of an increasingly globalised food trade, global market changes have a more substantial influence on prices than the conditions of local production. As a consequence of poor harvests in non-European countries caused by climate change and because of the increase in oil prices, food prices go up fast even in EU states having favourable agricultural conditions. This may increase social tensions, or increased emigration, especially in cities in areas with limited agricultural potentials.

The solution is to develop the local economy and to use the possibilities offered by the green economy. This way, the production of peri-urban agriculture can also be increased, which in turn can help reduce dependence on external supplies and improve the security of supply. Also, with the ensuing new employment possibilities and higher incomes, social tensions in the cities can be reduced, too.

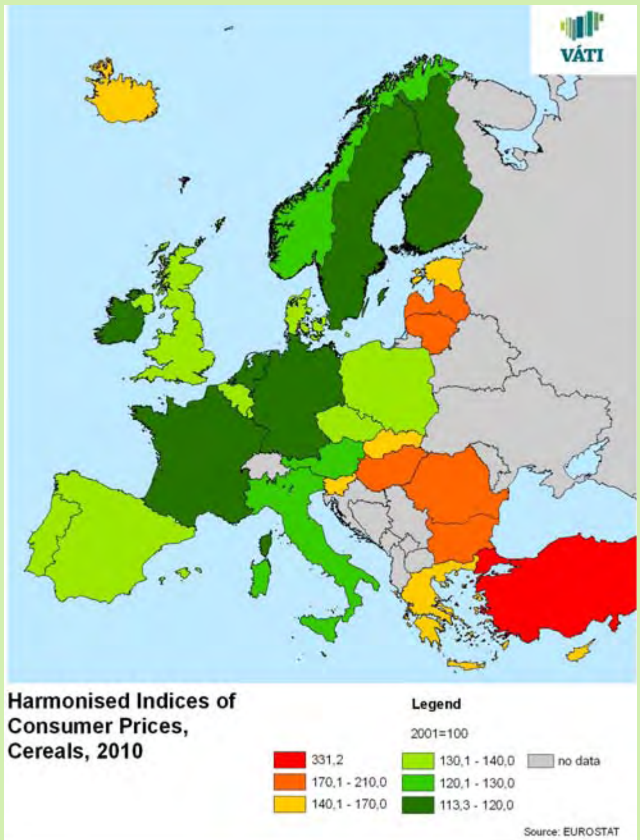


Figure 33: Harmonised indices of consumer prices, cereals, 2010

11.2. WIND-RELATED PHENOMENA, IMPACTS AND ACTIONS

Damages caused by wind storms are typically joined by the extreme manifestation of precipitation; they are capable of causing significant damage to buildings which can be critical and not restorable for the more vulnerable strata.

The possible areas of community interventions may be the following:
– Taking preventive and comprehensive measures, the basis of which is making the buildings resistant and supporting the related expenses from community.
– Elaboration of rescue scenarios for cases when evacuation is the only possibility with the primary focus being protection of life.

11.3. PHENOMENA, IMPACTS AND ACTIONS RELATED TO TEMPERATURE EXTREMES

In urban conditions, one of the greatest sources of danger is the numerous detrimental consequences of summer warming. Heat waves occurring in the hot summer periods cause problems mainly concerning the health and lifestyle of people living in densely built urban areas lacking the conditioning effect of water and green surfaces.

Heat waves (which lack of proper protection, cooling, access to water surfaces) are detrimental to health, and have an especially unfavourable effect on deprived groups. The extra costs related to cooling and its technical condition cannot be financed without external support in many cases.

Enduring an unexpectedly cold winter effects deprived groups and homeless people by endangering their everyday life. The extra costs relating to heating cannot be financed without external support in many cases. Especially the costs of heat insulation or heating modernization can prove to be impossible to finance even by people living under less deprived conditions.

The possible areas of community interventions may be the following:

- **Improvement of housing conditions**: restoration, insulation, and cooling of buildings, i.e. supporting deprived people in participating in such programmes.
- **Supporting extra costs** (heating, cooling) due to climatic changes under an arrangement adequate for people in deprived situation, so they do not become victims of these processes and not be affected by health damage as a result.
- **Improvement of residential conditions**: more green areas, water surfaces, and installation of public wells where the presence of deprived groups is large. Surveying the restoration of public spaces has especially great importance. City districts where the number of non-insulated or badly insulated buildings is large and there is not enough financial means available for the operation of air conditioning installation (which is especially characteristic for segregated residential areas) should be given priority.
- Fast **community intervention** in serious cases. Adequate information, distribution of water, and assistance on public spaces must take place during a heat alert. Typically, these actions concentrate on city centres, however, the necessary surveys referred to several times show that the segregated quarters are also in sore need of distribution of water and assistance in public spaces.

Overall, we must strive to achieve that all social groups should be prepared for and protected against the climate change processes occurring with variable predictability. In case of those initially starting with disadvantages with regard to preparation and gaining protection, much more attention, sources and communication activities should be concentrated.

The support forms and assistance should be separated between those aiming at the mitigation of already predictable extra costs related to normal lifestyle that can be traced back to climate change (e.g. colder, longer winters and demand for extra heating, which may not be affordable by the deprived family), and the arrangement of the non-affordable extra costs incurred due to a non-predictable, one-off damage arising in the urban environment.

Disadvantages deriving from the lack of information must be considered seriously; these can be tackled mainly with community intervention and primarily by active communication. In this case active communication not only means that attention is drawn to the support possibilities in the accessible media, but also that frequent communication is established with the leaders and influential members of the community in order to create better possibilities for the flow of information.

Amsterdam, 'Step2Save' – Energy-efficiency advice for city tenants

Amsterdam is the capital of the Kingdom of the Netherlands; its population is around 755,000.

In 2006 a project was started to increase the energy-efficiency of city tenements with the objective of reducing energy consumption costs for 10,000 households, who live in social housing. Through this, the level of CO_2 emissions can be reduced and the energy costs of tenants will be lowered. The project includes a training that facilitates the currently unemployed tenants to find jobs. In order to implement the latter objective, the persons advising on energy-efficiency were selected from the young unemployed, who were given one year of guaranteed job opportunity following the training. During the programme, the Labour and Social Affairs Department selected jobless people between 18-30 years that could participate in a training implemented by NUON. During one year following the training advisers had to visit the 10,000 tenements and give free energy-efficiency advice and assist with the commissioning of the new energy-saving devices.

As the result of the project, a total of 10 advisers were trained in 2006. In 2007, 107 applicants signed up for the training. During the one-year implementation the advisers rang the doorbells of every apartment. This solution proved to be significantly more efficient than the previous versions, where an appointment had to be made for advising. Nearly 6,000 'energy boxes' were distributed that can result in a saving of 200 kg of CO_2 on average in case of every household, reducing household energy costs by 5% on average. (Image: nieuws.nuon.nl)

Besides the City of Amsterdam, the main parties involved in the project were Energy company NUON, Housing corporation Far-West and Ymere and Philips as the sponsors.

Contact:
City of Amsterdam, Environmental and Building Department
E-mail address: s.bouwman@dmb.amsterdam.nl
Telephone: + 3125206363

11.4. DEVELOPING THE DEPRIVED AREAS

When helping groups who suffer from the negative effects of the climate change, it is also very important to localise the areas where the assistance is needed. Supporting vulnerable social groups in the adaptation to the climate change therefore has a significant territorial aspect along social features. Hence settlement and regional development in disadvantaged areas is a very essential part of creating climate-friendly cities, the problems of deprived groups are related to the city they live in.

The negative effects of climate change tend to threaten more significantly the cities that are situated in **socially and economically underdeveloped regions**. These cities can not respond to the challenges posed by the climate change without financial and professional help of the government or other organisations.

Other types of disadvantaged cities are those situated in **environmentally vulnerable areas**. For example settlements of the Mediterranean coast realise a shortage of water. Thus these environmentally sensitive cities and their surroundings are already facing negative impacts of climate change. Solving these environmental and social problems is the challenge of the near future. There can also mixed types of areas (which face social, economical and environmental problems as well) like some regions in Greece, which are as well on the coast of the Mediterranean Sea, and also have numerous deprived groups living in the country.

Regardless of where they are situated, if there are deprived groups in the city or region, the main problems are usually the same:

- Local economy is not strong enough to ensure acceptable standard of living for the inhabitants.
- There is a high unemployment as a consequence of lower number of working places than necessary.
- Underdeveloped infrastructure.
- The city's government does not have adequate instruments to develop the settlement, and respond to the effects of climate change.

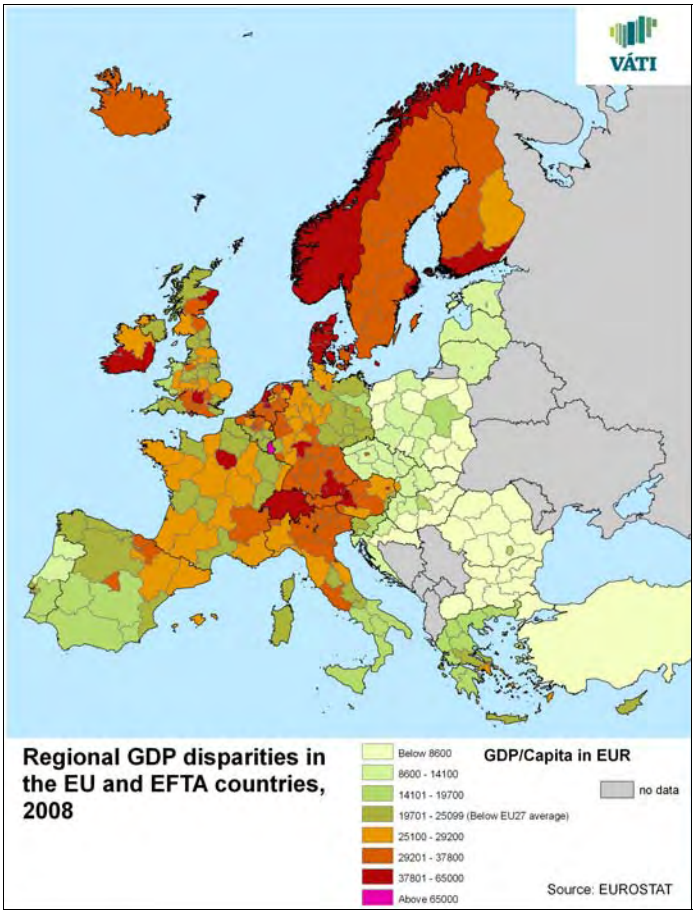


Figure 34: Regional GDP disparities in the EU and EFTA countries, 2008

Cities where deprived groups live have to find answers for the aforementioned problems.
Hereunder there are some solutions that can help disadvantaged cities in the adaptation to the climate change:

- The development of **local economy** considering the protection of the local and global environment, especially the reduction of air pollution.
- The **green economy** helps to settle new sectors in the cities while retrofit may stimulate the local economy and create new jobs. This way deprived cities and regions can find new chance for development, as mentioned in the Chapter 12 about climate-friendly urban economy.
- The **development of infra-structure**, especially public transportation and technical infrastructure in harmony with nature reservation.
- The **employment of experts** who make policies and projects to help the city in adapting to climate change. These policies and projects can help cities to make adequate decisions in environmental issues, especially in the case of climate change.
- Establishing regional, national or international **co-operation between cities** that they can share their experiences, knowledge and projects in adapting to climate change and economic development in the changing environment. Creating international networks can make information flowing easier between partners.
- **Education** and improvement of the city's inhabitants' environmental awareness.
- **Monitoring and analyse** of the changes of the city's environmental state. Preparing answers for the problems which occurred.
- Monitoring the city's actions in adapting to climate change.
- Financial assistance of the cities for adapting to climate change.

Prenzlau 'City of renewable energies'

Prenzlau, a city in the Uckermark District of Brandenburg in Germany, has a population of about 21,000. In the wake of German reunification, many businesses closed, others reduced their staff considerably. The unemployment rate of the district, is much higher, 11.7% in 2009, than the regional average.

Prenzlau shows that the environmental friendly energy supply in the context of global climate change is not only necessary but offers significant opportunities for growth as well. The city council has approved a mission statement according to which Prenzlau should be a 'city of renewable energy'. The use of geothermal energy, wind power and solar energy and the cultivation of renewable raw materials and their processing into biomass and biogas have ensured that the city now produces more electricity – from renewable sources –, as it consumes. Already around 1,000 jobs have been created in the business sector of renewable energy in the city.

The aleo solar AG which produces and sells solar modules using silicon cells was founded in 2001 and the production started in Prenzlau in 2002. The production capacity expanded to 180 MW by 2010.

The world's first hydrogen hybrid wind-biogas power plant is built in Prenzlau. It combines the three energy resources to provide reliable supply regardless of the weather. Wind turbines produce more electricity than currently needed and an electrolyser converts the excess into hydrogen. In low wind periods energy produced from biogas compensates the electricity production.

For heat production even geothermal power is used in Prenzlau. Today the heat is fed into a district heating system which supplies a significant part of the downtown with heat and hot water. The operation is very reliable; it has low maintenance demand and cost.

In 2010 Prezlau won the third place in the category of '*to 20,000 inhabitants*' in the competition 'Federal capital of climate protection' and got the 'Climate Municipality 2010' title.

Contact:
Stadt Prenzlau
E-Mail: stadtverwaltung@prenzlau.de
Web: www.prenzlau.de

BRIEF RECOMMENDATIONS

- Identification of deprived social groups in local levels.
- Motivating local governments to perform surveys that characterize the probability of preparation among the deprived groups from their own means and its extent with regard to climatic effects.
- Supporting compliance with construction standards and regulations.
- The support forms and assistance should be separated between those aiming at the mitigation of already predictable extra costs to be traced back to climate change, and helping the arrangement of the non-predictable, non-affordable extra costs incurring in urban environment.
- Elaboration of prevention and rescue scenarios in the event of danger.
- Drawing attention to support possibilities in local media.

12. ECONOMIC EFFECTS AND THE ENHANCEMENT OF URBAN ECONOMY

The climate acting as the natural environment and providing the natural resources for economic activities affects the economy in many ways. The close interrelation between the process of climate change and the economy is especially direct in cities. The changing climate does not offer only challenges, but also economic opportunities. These opportunities may be the consequence of climate change, but the actions on managing climate change possess more significant economic development perspectives. Climate change-related economic intentions significantly affect the future of cities: how they can adapt, how they can take advantage of the opportunities instead of suffering from the changes they will face. To establish a relevant and efficient urban economic strategy, the cities have to consider all climate change aspects of their economic policy (the current chapter highlights these main aspects).

12.1. THE URBAN ECONOMIC IMPACTS OF CLIMATE CHANGE

The direct economic effects of climate change are easily predictable. However, their magnitude is highly dependent on the geographical location of a city, its economic structure and strength, so generally it is not possible to estimate easily.

- Very positive effects can be expected in some regions, such as the reduction in heating costs, especially in Central and Northern Europe.
- A significant improvement is predictable in the navigability of the Baltic Sea and the traffic of Baltic port cities. However, the change in the weather and stronger storms will increase shipping costs everywhere in Europe (e.g. delays, average, damaged goods).
- The strongest negative effects are linked to the extreme weather events. Floods, fires, storms, rising sea levels and increased coastal erosion, high surges themselves can cause serious damages and losses. Some of these phenomena however can occur either as a group.
- Water supply is already a major problem. It mainly affects the Mediterranean macro-region, especially the islands. Water scarcity is strengthened even more by climate change. In the most affected areas water is already the main limiting factor of many aspects of development.
- Tourism is one of the most climate-sensitive economic sectors of the cities. The summer heat waves in Southern Europe may cause a reduced number summer tourists, creating a gap during mid-season. This is offset by longer spring and autumn seasons. In cooler regions of Europe, the warmer weather would increase the development of tourism. Furthermore, tourism is a dominant economic sector in many areas suffering from water scarcity, and the demand for water of tourist attractions is high (parks, spas, hotels, etc). The winter temperature and precipitation trends have also a key role in the economy of mountain ski centres. The shortening of ski season can be very significant especially in the towns lying at lower altitudes and having southern-facing slopes. Climate change also has important impacts on other tourist destinations, e.g. the disappearance of beaches due to rising sea levels or damaged monuments.

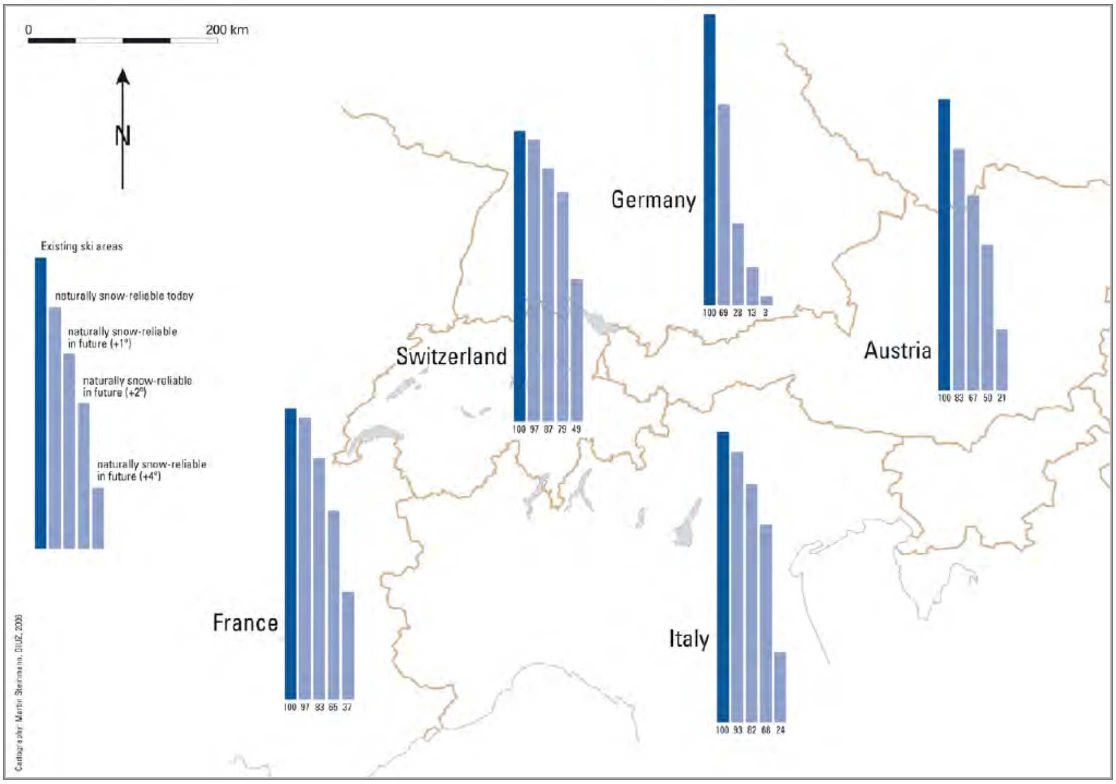


Figure 35: Number of natural snow reliable ski areas today and in future: +1°C (2020s), +2°C (~2050), +4°C (~2100) (Source: Abbeg, 2006)

– Agriculture and management of urban green areas are facing some benefits in some areas, but more danger in others. The agricultural opportunities in the city's neighbourhoods may improve, particularly in the northern part of Central Europe and Northern Europe. The longer and warmer growing season in these areas can have a positive impact on urban green areas in the northern parts of Europe. Alternatively, the difficulties in water supply and the shift of bio-geographic zones, along with the northward spread of southern animals and plants cause serious threats for the agriculture in city neighbourhood and the urban green areas.

Indirect economic impacts can be experienced in most areas of life. These effects are mainly harmful as well, but they can also be favourable sometimes:

– The damages in infrastructure and transportation are highlighted by the raising the prices of most products that may weaken the city's economic development.
– The renewal and development of infrastructure (roads, pipelines, buildings) due to the threat of flooding and coastal erosion also has significant costs. However, these investments give also provide for economic production and jobs.
– The increasing damages caused by the weather increases insurance costs. The city's exposure to climate and environmental safety affects the risk of investment, and thus the opportunities for economic development.
– Agriculture affects cities only indirectly, but its reduction in productivity can have a serious impact on a city. The rural unemployed people can be urban job seekers in the nearby towns or in remote cities, even in other continents. It depends on the city's economic strength and innovation potential whether the 'climate migrants' will be new human resources or will cause a more major social problems to solve.

The economic impacts of climate change – without an active intervention – will be positive only on a few sectors and regions. For the large majority some kind of adaptation will be inevitable, and this is the only way to exploit the favourable business opportunities.

12.2. THE ECONOMIC IMPACTS OF MITIGATION AND ADAPTATION

The mitigation and adaptation measures are now an essential part of urban life. More and more cities are recognising and applying this discipline. However, the measures require new investments and need financial resources. The question arises: to what extent are these investments profitable? The cost of action has to be compared to the cost of doing nothing. Due to so many different conditions and risks of different locations, there is no precise figure that can be used to define the price of an action. However, there are studies in some sectors about the costs and benefits of mitigation/adaptation. A review of the economics of climate change for the UK Government (Stern, N. 2007) suggested that an average 1% of the annual GDP will be needed to adapt to climate change. While the cost of 'doing nothing' rises to 5 – 20 % of GDP in 50+ years time. The costs of 'doing nothing' will grow as the effects of climate change will become more and more critical. The wise mitigation and adaptation measures completed in perfect time will bring more profit and save more money than doing nothing. The OECD made calculations as well about the effects of mitigation policies on the economy of metropolitan regions (OECD, 2010). The evaluation is based on the OECD Metropolitan Database modelling the mechanisms of cities through a general equilibrium model. The results show that in the first 20 years the economy will decrease significantly, but this will be only a temporary state. The increased price of carbon emission leads to new technical solutions, thus in the next era the economy can grow, as the new technologies and the increasing energy-efficiency contribute to the mitigation of the vulnerability of oil prices and to saving costs.

12.2.1. Economic opportunities related to mitigation

Mitigation can seem to be a costly and less profitable solution for the public. There can be very high costs when mitigating, such as the transformation of urban transport or a modernisation of a district heating system. Still, mitigation can be the only solution for slowing down climate change. The lack of mitigation increases the negative effects in the future, and so adaptation will become more costly. This alone proves that reducing greenhouse gas emissions is a good investment.

However, we must take into account other associated effects. These benefits make mitigation financially profitable:

- **Reducing energy use** is a significant way to save money. The less the energy demand is, the more the reduction of the load on the supply system will be, so this can operate more safely, and costly improvements may became unnecessary. In Hungary, for example, The 'Virtual Power Station' programme aims at this. The planned energy savings by 2020, will reach the output of a small electric power station.
- Reasonably regulated urban transport and wise urban planning not only reduce transportation fuel demand, but the other costs of transportation (e.g. amortization of vehicles and roads) and the time as well.
- The **use of renewable energy sources** does not just reduce the dependency on distant energy sources, but creates labour intensive economic production (jobs for lower and higher qualified people) and increases the safety of energy supply. The cost of locally produced energy is more predictable and more economical to use.
- The **use of recyclable materials** also reduces GHG emissions, especially in the construction industry. The high energy demand of making building materials (e.g. glass, cement, concrete) and construction thus can be significantly reduced. The environmental burden (mining, construction waste) also can be reduced by the use of recycled building materials.
- A **well-managed urban development** and a climate-friendly urban structure can provide significant support for mitigation and adaptation measures, so they can improve the economy.
- The energy-efficient buildings compensate for the investment of the costs of operation.

One form of mitigation is **emission trading**. The OECD examined 10 cities worldwide, how these cities can use this opportunity to support their own climate strategy (Clapp C., A. Leseur, O. Sartor, G. Briner, J. Corfee-Morlot, 2010). The lessons are summarised below.

The carbon market has become an important mechanism for financing low-carbon technology choices. Carbon markets could offer potentially significant support to viable urban mitigation projects, working alongside other financial and policy instruments (e.g. taxes, bonds, subsidies, norms, etc). However the participation of urban authorities and of urban mitigation projects in the global carbon market remains extremely limited. The existence of carbon credits may not change the principle design of a pre-existing urban project, but can provide a supplementary revenue stream. Since the rules and legislative frameworks that create and regulate carbon markets have not been designed with urban mitigation projects in mind, various legal, technical and financial barriers to offset markets often appear to be insurmountable for urban projects. In the very rare case when the company with greenhouse gas emission allowances is in the possession of local authority (e.g. local heating or power plant) there is a chance the city to use this allowance as financial resource for mitigation measures.

The challenge is how to best tap the potential for carbon markets to offer increased levels of financial support for urban mitigation projects or programmes. Suggestions for possible solutions include: developing methodologies for urban programmatic or sectoral projects to boost the volume of urban emissions, and simplifying the project development phase to accelerate the pace of project development and approval and reduce transaction costs. Beyond existing market mechanisms, other avenues that could be explored for urban mitigation projects are domestic offset mechanisms and possibly participation in national cap and trade systems. These are already viable options in the case where national governments have taken on a national cap as they do not require changes in international market rules. Examples of existing or proposed systems include: in New Zealand, Germany, France and most new EU Member States, where the domestic offset option is technically already in place using the JI architecture; and in the US, where the idea of regional or federal domestic offset projects has been proposed. National governments and international organisations will need to act to create urban-friendly carbon markets. First steps could include: subsidising the development of relevant urban methodologies for key sectors at urban scale, working through national governments to simplify and reduce costs of the project approval and verification procedures for urban projects, and advancing internationally harmonised accounting methods and reporting guidelines for urban emissions to help cities identify potential target areas for mitigation projects and provide a consistent accounting framework to integrate with national policy frameworks.

A new model for financing emission cuts

How could we get from climate planning to action in the local government sector? As an answer to this the Norwegian Association of Local and Regional Authorities, KS, has proposed a new mechanism for financing local emission cuts, where the state actually buys carbon cuts from the municipalities.

The mechanism, called KLOKT (*wise* in Norwegian) is based on the municipalities own climate and energy action plans. All measures selected for sale will there be formulated and calculated in a standardized system, with a calculated effect per measure in tons of CO_2-equivalents and a price per ton. All calculations are to be verified by an approved third party. On the basis of this verification, a regional negotiating body, the County, will undertake the price negotiations on behalf of the local governments – and the state is free to buy the proposed cuts or not. When the measure is completed, any excess money could be kept by the local government, while deficits have to be paid on the municipality's own account.

Photo: Trygve Schønfelder

According to KS, the mechanism can easily be combined with existing grant systems. If any grant is included, the amount will be deducted from the final price. Obtained cuts will not be resold or included in international quota systems in any way. Internationally they will be registered indirectly through national statistics reported to the UN. However, all measures will be formulated according to UN-regulations.

The KLOKT-proposition is a result of a comprehensive R&D-program, totaling 500 000 euro, financed solely by KS. This program, started in 2008, also includes the pioneering development of a system for quantifying local emission cuts in a standardized manner. The proposition is included in a report, published in 2010 by a Norwegian governmental working group, on possible new measures for achieving Norway's 2020 emission target.

One of the projects resulted from this mechanism is the new light rail line (Bybanen) in Bergen. It was financed by the city, the county and the state in co-operation, and has became a great success since its opening in 2010.

The following chart summarises the economic impact of mitigation options.

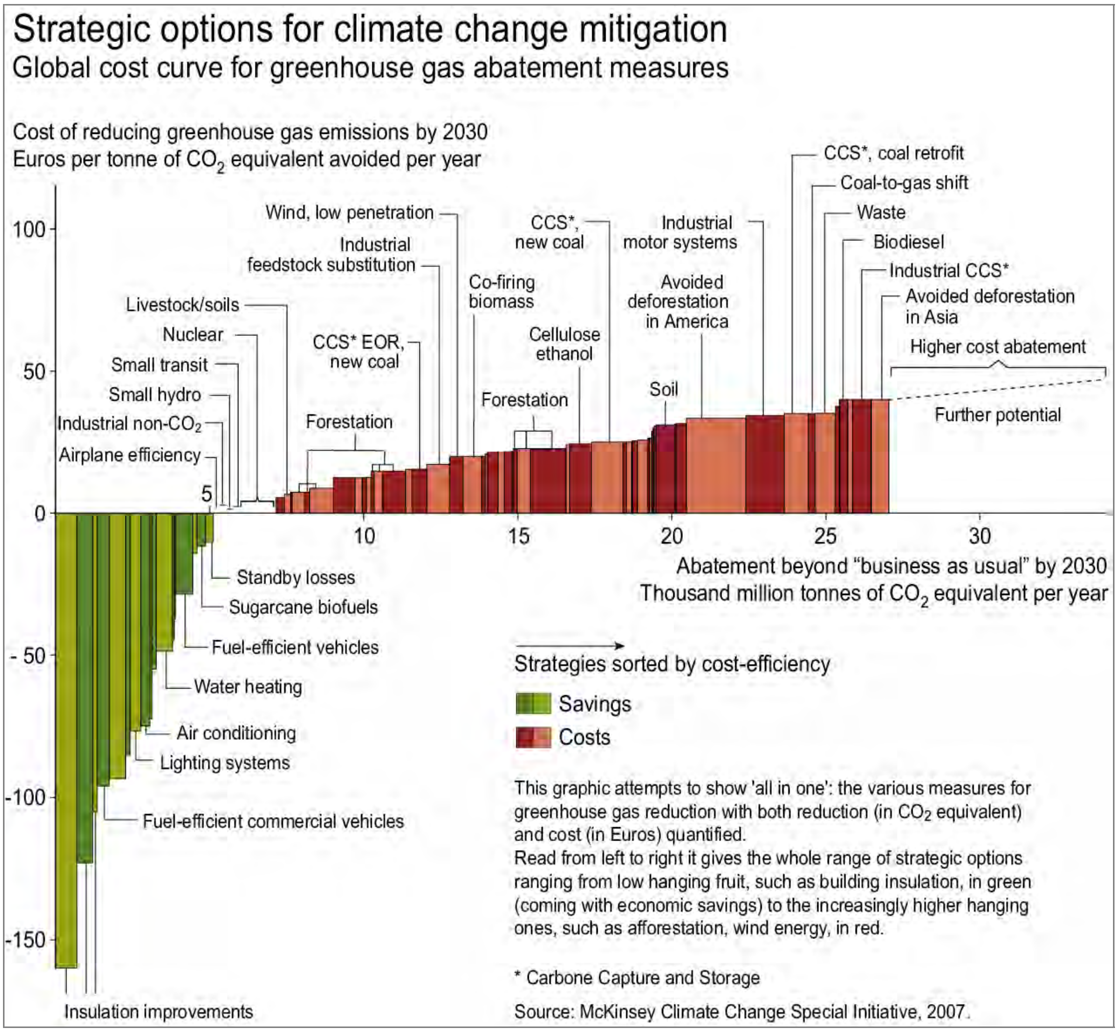


Figure 36. Strategic options for climate change mitigation (Source: Kirby, A. 2008)

12.2.2.Economic opportunities related to adaptation

Adaptation is necessary to maintain environmental safety and protect health. The cost is often very high, but one can find economical solutions. For instance, direct and easily measurable way to see the effects of water saving. Increasing environmental safety (flood protection, coastal erosion, technical infrastructure, road safety) can itself be profitable, if the damages caused by disasters or power outages are taken into account. However, its indirect benefits can be even more considerable. The greater environmental and transport security, the greater reduction of the insurance premiums. Modern urban structure, energy and water efficient buildings make the city more liveable and more attractive. All this contributes to the development of the housing market and rising house prices which can bring a direct benefit to the citizens. A more liveable city in the era of increasing environmental stress will be more attractive in economic terms.

12.3. CITIES TOWARD NEW CLIMATE-AWARE ECONOMIC MECHANISMS

12.3.1. The green economy and the cities

Bringing green economy to the forefront of action may significantly contribute to improving the climate of cities and towns. However, this requires that all actors of both, society and economy adopt a new approach.

The economic crisis emerging during 2008 has, in many ways, changed how we think about the global economy. Many have since questioned whether economic growth will be lasting at all. Experts believe that both, the crisis and the planet's ever more severe environmental problems, can be best tackled through a new economic approach, a new direction in development, one which emerges along the lines of sustainability.
If we seriously try to retrofit our life-style into a sustainable one, economic change is necessary. Up to this point, we have not reckoned with the several externalities of present-day economy, therefore we cannot recognise their absolute impact. To reduce them, the long-term solution is supporting the transition to green economy.

There are numerous definitions of what constitutes a **green economy**. It can be considered as a 'methodology of economics that supports the harmonious interaction between humans and nature and attempts to meet the needs of both simultaneously' (www.investopedia.com/terms/g/greeneconomics.asp). Green economy results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities (UNEP, 2011). Both expositions demonstrate the importance of this reasonable and responsible economy, which has been created by the recent global crises. Green economy has become part of the action plan of quite a few countries and governments. It is a dynamically emerging new model for organising and developing the economy, as well as managing the market.

Transforming the current economies means structural change. This is an invention for sustainability that tries to take the ecosystem into consideration. It relies on renewable energy sources, unlike the 'black economy' model that is based on fossil energy sources. Using alternative energy is not only more environmentally friendly, but it can also stimulate the economy and create relatively more jobs. (Emerging and developing countries should also change their structure, eliminating the failures of the 'developed' nations.) The main effects we expect from the green economy when compared with the current method: a less troubled and healthier environment, safer energy-supply, new economical sectors and jobs, more R&D opportunities, and innovations etc.

In most countries, cities will be important sites for the emerging green economy. The urban economic development has the potential to be a new engine of growth. This is because of three fundamental reasons (UNEP, 2011):

- First, the proximity, density, variety intrinsic to cities delivers productivity benefits for firms and helps stimulate innovation.
- Second, green industries are dominated by service activity – such as public transport, energy provision, installation and repair – which tends to be concentrated in urban areas where consumer markets are largest.
- Third, some cities will develop high-tech green manufacturing clusters in or close to urban cores, drawing on knowledge spillovers from universities and research labs.

12.3.2. Engine of growth: green jobs and sectors

Creating green jobs
For a dynamic green economy, trained labour is of vital importance; without this, transition will be hampered by predictable difficulties. In this respect, cities are in a favourable situation as they can train and retrain labour locally, based on a thorough understanding of the needs of the local economy.

Greening the cities can **create jobs** on a number of fronts (UNEP, 2011):
1. Urban and peri-urban green agriculture
2. Public transport
3. Renewable energy
4. Waste management and recycling
5. Green construction

The following table aggregates several examples for green firms and jobs (OECD, 2010).

Category	Sectors	Examples of jobs
Renewable energy	– Hydroelectric. – Solar PV. – Solar thermal. – Geothermal. – Wind. – Bioenergy. – Combined heat and power (CHP).	– Energy engineers. – Electrician and plumbers installing the system. – Mechanics buliding the infrastructure. – Renewable energy plant operators.
Transportation efficiency	– Urban Public transport. – Railways. – Urban cycling amenities.	– Public transport drivers and emlpoyees. – Bus retrofitters. – Builders of rail networks, tramways and bicycle paths.
Green manufacturing, construction and product design	– Retrofitting. – Energy efficient building materials. – Building maintenance and contracting. – Domestic and office equipment and appliances. – LED (light emitting diodes). – Cleaner coal technologies. – Biodegredable products. – Hybrid vehicles.	– Engineers and scientists working on energy efficiency improvements (efficient lighting, smart metering, low energy monitors, advanced and efficient production processes…). – Chemists developing environmentally friendly packaging, cleaning products and sprays. – Employees of firms producing green building materials (alternative cement, recycled wood…).
Waste and pollution control and recycling	– Mobile and stationary air pollution source controls. – Water conservation and reuse. – Pulp and paper recycling. – Aluminium recycling. – Electronic recycling.	– Workers employed for renewing water infrastructure. – Hazardous material removal workers. – Recycling plant engineers and operators.
Environmental analysis, training and consulting	– Landscape. – Public administration. – Specialised consulting and marketing. – Green venture capital and other financial services.	– Energy contractors. – Specialised consultants. – Trainers. – Marketing specialists. – Green-civil engineers. – NGOs.

Table 2: Green firms and jobs (Source: OECD, 2010)

Naturally, there will be job losses in traditional sectors such as mining, or heavy industry, moreover better efficiency and automated procedures will cause some job reduction. After all, there is a lot of potential in present labour processes, where possibilities of work can be flared. For instance, recycling is able to employ manpower in many industries. There are activities in metal-processing that depend on valuable by-products and scraps. In the pulp and paper industry, where modernised and more efficient plants require fewer workers, recycling is the fastest growing source of substitute and new green employment (UNEP, ILO et al. 2008 in UNEP, 2011). Green manufacturing gives new products to the market ranging from engineering, electrics, architecture and other sectors.

Manchester - Co_2llective action on climate change

In 2009 Manchester City Council created a future plan aiming to reduce the city's contribution to global warming by cutting the emission of CO_2 by 41% by 2020 from 2005 levels so to become a truly low carbon city by 2050. In order to tackle climate change, this action required the involvement of every stakeholder; local communities, residents and the business community have also taken part in the initiative. The plan proposes to create a low-carbon culture thus gives guidelines related to all our actions: whether we are at home or we work, also it deals with the possible tools of the economy and adaptation.

Greening workplaces and the world of business play enormous role in the city's transformation. Green jobs will be supported by different ways:

- Providing a centre of excellence for green collar skills and training for the construction industry.
- Creating new recycling centres.
- Encouraging low-carbon investments in the city and taking incentive measures, such as the reduction of business rates.
- Supporting the growth of repairs and services as a part of an effort to reduce waste and energy use.

Low-carbon industries in Greater Manchester already have a market value of £4, 240 million, employing 32,600 people in 1,900 companies. Their annual growth rate is a healthy 4% despite the recession. According to a large-scale conception in 2020 major programmes of retrofitting homes, public and commercial buildings and creating new energy networks are likely to be supporting 15,000 jobs.

Low-carbon innovation and research have a strong profile in the city with the Tyndall Centre Manchester, which is at the very forefront of national and international research of climate-change. Their colleges, universities and science parks provide a highly skilled and adaptable workforce which will be critical in tackling climate change, as well as in being possible incubators of emerging enterprises in the green economy.

Contact:
Manchester City Council
Telephone: 0161 234 5004
Web: www.manchesterclimate.com/home
E-mail: contact@manchester.gov.uk

Investing in green sectors

Beside broad present activities, there have been **new sectors** evolving within a green industry. Five main categories of green industries relevant to cities and metropolitan regions can be distinguished (OECD, 2010):

1. Renewable energy and energy efficiency.
2. Transportation efficiency, new modes of transport and substituting transport.
3. Green manufacturing, construction and product design.
4. Waste and pollution control and recycling.
5. Environmental analysis and consulting.

It worth highlighting some possible climate protection aspects of a green economic development, which can be organised at the level of the city:

– In terms of climate protection, one of the most important interventions in cities is the **renovation of the building stock** taking into account improved energy efficiency. In addition to the obvious positive environmental effects, this also stimulates the economy as it opens opportunities for a construction industry shaken by the economic downturn.
– The production costs of green energy are still relatively higher than those of fossil energy. There are programmes called '**green pricing**' in which consumers agree to pay a surcharge on energy obtained from renewable sources, a measure that balances the higher costs of production. In several European countries, producers introducing green energy into their systems are incentivised by receiving premium rates.
– '**Feed-in-tariff**' systems offer discounts to consumers who feed renewable energy or recycled waste energy back into the network.
– Over the past decade, **industrial parks** have become common. These cater for industrial enterprises that may wish to settle in a location that offers existing infrastructure, local tax benefits, and, if possible, a range of services. A 'green' version of the industrial park is an 'ecopark' created on the basic principle that enterprises settling in close vicinity with one another rely on each other's by-products (e.g. thermal energy) in a cyclical system.

12.3.3. R&D and innovations for green growth

Research and development relates closely to all progressive sectors of the green economy (renewable energy and energy efficiency, transportation efficiency, green manufacturing and construction, waste management, environmental consulting). R&D has the most significant role in creating green technologies and providing solutions in every economic sector. Innovation can assist in diversifying energy sources away from those most harmful to the environment and help deliver greater energy security as well.

There are '**first mover economic advantages**' to cities that innovate and take advantage of the green economy (estimated to be worth $500 billion globally by 2050) and avoid 'lock-in' to uncompetitive high carbon economies that may become increasingly vulnerable in a globalised world. Technological expansion employs more and more scientists and researchers of universities, think tanks and firms all over the world. It can be stated that inventing and developing green innovations have become a **self-dependent industry** at this time. Forming knowledge bases and trainings of environment-friendly and sustainable economy are not only marketable products, but foster spreading responsible attitude among people. Due to researches in the manufacturing process already are used different water and energy-saving, waste-less or zero-waste technologies, which can minimise and reuse resources without distressing wastage. Renewable energy utilization is the first base of investigations, because many other pursuits are based on it. Electricity and heat-energy production, transportation, building industry etc. can use renewable-energy converter implements.

Small and medium enterprises (SMEs), which play a major role in the European economy and which are favoured by EU economic policy, find it difficult to join these processes of eco-innovation because of their low innovation potential. Organising **co-operation schemes** in urban areas – where the institutions of innovation are normally concentrated – can offer one solution to this problem. Within the framework of such co-operations, research and development sites and universities can test their technologies and processes in realistic conditions while enterprises may benefit from the advantages offered by such novel solutions. City managements can play a significant role in creating and running co-operating networks of this type.

Turin, Hydrogen Systems Laboratory (HYSYLAB)

Turin is one of the most important industrial and financial centres in Italy with a population of around 910,000 and a the metropolitan area of around 2.2 million. This is ideal for research and development activities.

HYSYLAB is located in Turin. The laboratory was funded and built between 2006 and 2008, with the financial assistance of ERDF. The laboratory's mission is the production, application and system integration of hydrogen. Hydrogen is an alternative resource for energy supply and fuel for vehicles. The usage of hydrogen is very climate-friendly, because the emission of greenhouse-gases is very low. The institution creates and develops metal hydride storage devices, hydrogen compressors, hydrogen injectors, fuel processors, and other devices and systems. HYSYLAB also trains technicians, and does testing on hydrogen technologies. The organisation employs young and talented experts to make more dynamic researches, and to improve employment in the region.

Hydrogen System Laboratory has many projects at the same time. For example the Laboratory is creating a new scooter that runs with hydrogen. Another project promotes a cell that produces energy for heating. There is also an urban related project, the BioH2Power, which studies renewable gaseous fuels made from waste for current and future vehicles. The institution's future plan is to increase co-operation with private companies, and enforce national and international networking activities.
HYSYLAB can be an exemplary project in climate-friendly research and development, and in giving technical assistance for cities in adapting to climate change.

Contact:
HYSYLAB, Via Livorno 60., I-10144,
Torino, Italia (Environment Park)
Phone: 011 225 72 22
Web: www.hysylab.com
E-mail: hysylab@envipark.com, chiara.massaza@envipark.com

12.3.4. Raising citizen's environmental awareness for green growth

By raising citizen's environmental awareness, consumption of **green products** could be invigorated. Juristic regulation, labelling or environment-friendly marking are incentive implements to produce and buy sustainable products. It is favourable either for the economy, or the ecosystem. The social benefit, besides creating new workplaces, is public workers also would be employable for example by building regeneration. It is particularly conducive in deprived areas. Recycling materials neither need high qualified labours, so there will be several types of jobs available in the green sector for deprived groups too.

It is very important to ensure that various governance instruments are used to attain the interest of the population as well as the economic actors in developing and creating a green economy.

- One of the ways to achieve this is through the **dissemination of information** and through promotional activities. Various campaigns and special events can be useful in educating the population about this new direction in economy. (In addition, promotional events can also be organised where customers buying green products receive bonus points which they can use towards further green purchases.)
- Economic actors opting for green growth can be offered advantages through **local support policy** or **local tax policy**, which can be an even stronger incentive for them.

12.3.5. Responsible economic development

Responsible management has various conceptions; it includes several activities that contribute to achieve sustainability. The **fair trading** movement started in 1988 and took aim at creating a form of trading which was more equitable. 'Fair trade is a trading partnership, based on dialogue, transparency and respect, that seeks greater equity in international trade. It contributes to sustainable development by offering better trading conditions to, and securing the rights of, marginalised producers and workers – especially in the South. Fair trade organisations (baked by consumers) are engaged actively is supporting producers, awareness raising and in campaigning for changes in the rules and practice of conventional international trade.' (European Fair Trade Association 2001. p.1.) Responsible management can also be defined as department stores purchasing their stocks from native resource. In this case, shops could support native growers and companies and there could be energy saved.

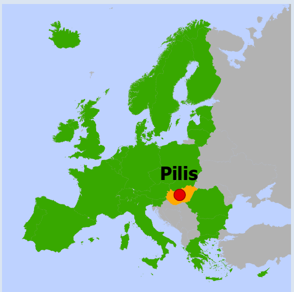
12.4. CITIES FORCING LOCAL ECONOMIC DEVELOPMENT

Local economic development can be an excellent tool in climate change mitigation. Developing the local economy means that the basic products and supply vital for the local population are increasingly produced locally, which in turn significantly reduces the need for transportation, thereby curbing greenhouse gas emission.

Achieving these and similar results often does not require any financial contribution from the municipal government. It is often enough to make local regulations more favourable. Changing local regulation can in itself create favourable conditions for the emergence of a more robust local economy, and thereby can improve local self-sufficiency.

The cities as markets

The cities have a crucial role in **organising the local economy**, as the European cities are the traditional markets of their neighbourhoods. European cities should accept this ancient role again. A city and its surrounding rural area should provide mutual services for each other affecting all the spheres of our life (e.g. providing jobs and labour, cultural and recreational experiences, industrial and food supplies, public and other services, and trading with more remote areas). Therefore, a city should be a site of stimulating the changing of local products and the purchasing of local services. A well functioning city in a close partnership with the other settlements in its region also tries to optimise the external and internal energy and material flows of the region. Although a city is a hub of long distance or global trading and purchasing, it should also work on limiting the needs of remote travelling and transport, thus satisfying demands locally.



Pilis, 'Climate Friendly Business' Movement

Pilis lies in the middle of Hungary, in the agglomeration zone of Budapest. It has 11.500 inhabitants.

The organization operating in Pilis – founded in 2007 – and called Climate Friends' Circle created a point system, and the shops of the city may become more climate friendly with the adaptation thereof. The system consists of 21 points, and at least 10 points have to be obeyed in order to win the title: 'Climate Friendly Business'. The points are as follows:

1. Continuously changing the plastic wrapping material to paper, or dissolving plastic (an obligatory task for everyone).
2. Recollect the used wrapping paper.
3. To market the domestic product in the shop-window that is aesthetically varied.
4. Production of the traditional, Hungarian products, or products made of Hungarian components.
5. Selling even more bio-products.
6. Do not pre-package the fruits and vegetables.
7. Collect the waste emerged in the shop selected.
8. Collect used batteries and printing patron.

9. Recollect the used oil, and hand them further to the sewage works or the company dealing with the collection of oil.
10. Secure a waste collector in front of the shop.
11. Carry back the household and technical equipments.
12. Raise plants before the shop.
13. Provide a bicycle holder or barrier to the buyers.
14. To sell paper bags that are proper for waste collection.
15. Use cleaning materials that dissolve into natural material.
16. Employees are not allowed to smoke.
17. Most of the employees go to work by bicycle.
18. The equipment is continuously changed to energy-saving, or one that is proper for the use of alternative energy.
19. The business is connected into the events of the city.
20. The shop organizes local shopping offer, showing what the business makes the difference.
21. Offers a 'Buyers' card' and discounts for the returning buyers.

The Climate Friends' Circle informed a meeting in July 2009 about its idea, where the shops of the city, the owners of the companies and the mayor of the city participated, who offered his support to the members, and the leaders of the shops. At the start 10 shops joined, but within a year further 14 shops joined. Their target is that within a few years they would like all Pilis shops to be climate friendly. They regularly organize meetings and the public information is published on the website of Pilis city.

Contact:
Pintér Sándor, e-mail: ecoline@monornet.hu
Hadas Jánosné, e-mail: hadasne@dunakanyar.net

Cities and their surroundings towards self sufficiency

Local economic development is also expected to take another direction: increasing the **self-sufficiency** of individual settlements and their micro regions and reducing their dependency on large supply systems will emerge as main objectives. Currently, a large part of water, food, and energy – all vitally important – is not produced locally, but instead, is delivered through what we call large supply systems. These large supply systems represent a significant load on the natural environment. How food is supplied to us today is a good example. By the time a given agricultural product reaches the consumer as food, it has been handled by so many processing plants and commercial enterprises that the energy used during processing and transporting the product is several times more than what the given product of food industry in itself represents. From the aspect of **food safety**, suburban agriculture is more reliable, than foods transported to a further destination. It is easier to control the quality of products, which come from a closer farm. Partly because of climate change, and partly because of the energy crisis, these large supply systems will become increasingly vulnerable, a fact that can easily lead to future disruptions in supply. Therefore, settlements should aim at creating local economy and local infrastructure that can provide for the population at least in terms of their fundamental needs such as drinking water, food, and energy when large supply systems become dysfunctional.

Obviously, larger cities have more restricted possibilities in terms of genuine self-sufficiency; accordingly, this is yet another area where it is a good idea to strengthen co-operation with the less urbanised settlements surrounding them. As the true significance of self-reliance becomes more and more appreciated, the economic ties between large cities and rural areas around them are expected to become stronger and stronger in the future.

Accordingly, the local management of settlements need to adopt measures that reinforce the local economy and thereby widen the possibilities of local self-reliance. There are several ways to arrive at self-sufficiency at the level of settlements which may be followed simultaneously.

– One way is for city management to **facilitate direct sales** between local/regional producers and local consumers. Currently, most examples of this modality are seen in the field of food supply (e.g. helping consumers and producers establish direct personal contact with each another, or making it easier for the local market to primarily serve encounters of this nature). One of the efficient instruments to strengthen the position of local producers and local production is ensuring that the settlement has a regularly functioning market. The European cities as traditional trading hubs serve perfect sites for these actions.

- It is possible to **enhance farming** even inside the city limits:
  - The municipal government must become an entrepreneur itself. Staying with the example of self-sufficiency in food production, the municipal government can be a land owner who can cultivate those lands or lease them out to other farmers. If the municipal government does not own any lands, it may purchase or rent them. Conversely, the municipal government can set up different types of processing plants (for example, slaughterhouses, mills, cheese factories, etc.) to process the agricultural products it produces or obtains from other producers. It is also reasonable to use public employment programmes for these activities.
  - Another option is when the population itself begins farming, not for commercial purposes, but instead, for its own consumption. All over the world, including in Europe, more and more city dwellers start farming either because they do not find reliable food sources and they like to spend time gardening, or simply because they do not have enough money to buy food. The latter is more typical of cities in the third world. This practice is very easy to establish in a suburban or more rural setting, but we see examples in large metropolitan cities as well.
- Turning abandoned urban areas and brown fields into cultivated land can also result in larger, more biologically active and healthier surfaces which help the climate too.

As an option, placing more emphasis on managing resources locally is not limited to achieving self-sufficiency in food production alone. In fact, it is also feasible in the case of such other fundamental necessities like energy. A great advantage of **using local alternative energy sources** is that it facilitates achieving independence in the supply of energy, which in turn, improves the settlement's security of supply in case the large supply systems should be disrupted (something that frequently occurs as a result of extreme weather events, among other scenarios). A further advantage of establishing a local energy supply system is that it can create additional jobs for the local population.

Local and regional economy development joined to the Amber Trail

Initiative of Amber Trail Greenways (ATG) is not a typical case of economic expansion, but through rural-, and ecotourism it could be linked to the protection of environment and also of economy. A renewed spirit of co-operation along the historic corridor, called Amber Trail empowers people and communities to generate sustainable economic and social development while protecting, restoring and preserving traditional cultural and natural values and landscapes. Amber Trail Greenways program provides local, regional and cross-border co-operation attended by three Central-European nations: Poland, Slovakia and Hungary.

The motivation and goal is to help people in Central Europe to use local heritage for local development. Amber Trail has seven UNESCO World Heritage sites that travellers can visit. At these sites local artificers and other businesses like hotels, can be amplified from the incomes which they get from tourism. Not just local economy grows, but the way of travelling is also climate- friendly. Greenways Travel Club offers cycling and walking tours where people can enjoy themselves, while learning how to show respect for the environment. Creating the infrastructure for these activities also helps local employment. Constructing cycling paths, and buildings for tourism and other activities can establish many workplaces.

Another excellent project is ITD Inspiration the local agency of Lanckorona region (Poland), which sells local heritage products including a variety of carved and painted images of angels, ceramics, linen products. ITD strengthens local economy by emploing a lot of people.

Amber Trail activities, initiatives and projects seek to reconcile conservation of natural and cultural values with the imperatives of economic development. It evokes the past times when trade was associated primarily with local products of great quality, which helped to bring prosperity to the local people and the places where they lived.

Contact:
Szerb utca 17- 19., Budapest, 1056. (Hungary)
Komenského 21., Banská Bystrica, 97401. (Slovakia)
Św. Krzyża Street 5/6., Krakow, 31-028. (Poland)
Phone:
+36-1-411-3500 (Hungary),
+421 905 240137 (Slovakia),
+48 12-430-24-43 (Poland)
Web:
www.ambertrail.info/what-is-the-amber-trail.html
E- mail:
info@okotars.hu; rohac@ekopolis.sk; atg.greenways@epce.org.pl

BRIEF RECOMMENDATIONS

- The city's economic policy may be one of the most important tools in shaping an urban climate policy if it is able to follow the goals and principles of a green economy and green growth.
- The green economy helps to settle new sectors in the cities; retrofitting may stimulate the local economy and create new jobs. Even the deprived cities and urban regions can find a new chance for development in this way.
- Innovation and knowledge will be more important and the new answers for the new environmental situations are a valuable export goods of the cities' economies. Moreover, this situation offers an opportunity to build a more aware, fair and sustainable economic model.
- Cities and towns can do a lot in a very straightforward manner to help prevent climate change just by functioning as local markets and strengthening an autonomous economy that encompasses both the city and its rural environment, and which aims at satisfying local needs from local resources.
- The support of citizens' climate aware consuming behaviour and lifestyle and stimulating their sympathy towards the green economic public investments, the products and services of the local economy and the fair trade are steps to leave behind that way of life which led us to not only environmental but also economic crises.

13. SOCIAL EFFECTS OF THE PROPOSED CLIMATE PROTECTION MEASURES

Concerning their social effects, the majority of climate protection measures proposed in the previous chapters can be regarded as neutral, since essentially they are based on community investment. They do not require individual contribution, and the various social groups have access to the benefits of the investments equally no matter what their usage rate is (e.g. energy-efficient pubic lighting, separated water drainage system, installation of mobile dams, and utilization of methane gas). It is worth studying the social effects of those interventions with greater care that affect certain social groups – basically the social strata with lower financial means, people living with disabilities, the elderly, families, people living in certain dwellings – especially deeply.

13.1. CITY TRANSPORT

Preferring the use of community transport is an important measure not only from the aspect of climate protection and sustainable mobility, but as an intervention having significant effects from a social point of view as it provides access to effective city transportation to city dwellers who do not have or have limited access to automobiles. Effective community transport, in practice, means creating a demand-oriented and barrier-free transport which operates with the least amount of transfers. Extension of community transport can integrate social strata currently immobile or with limited mobility not only into the transport system, but this way also into social life (e.g. people with disabilities, people with children, and elderly people with limited mobility).

According to a survey conducted in Germany (Mobilität in Deutschland 2008) between 2002 and 2008, the level of young people – between 18-24 years – who use automobiles significantly dropped, while usage of community transportation increased. Above 65 years, the tendencies are just the contrary: automobile usage somewhat increased, and the usage of public transportation decreased. This demonstrates that the relationship between the elderly age group and the usage of community transportation is not straightforward. In case the conditions of public transportation are not suitable for the elderly, then the provision of community transport systems in itself does not result in positive social impacts concerning this age group.

Nevertheless the extension of community transport systems is closely related to affordability. A wide-ranging transport network providing good access in itself can have motivating and positive social effects and enable the mobilization of newer and newer social strata. This depends on if the fee of the service is affordable and the development costs generated from investments are not directly transferred to the consumers. If the improvement of service quality results in ticket and pass prices hardly being affordable, the social impacts can even be adverse: social strata with low solvency will not be able to resort to the service level that they previously could afford. Nevertheless, affordable transport is a key issue also from the deprived group’s viewpoint, and is one of the most important conditions for dissolving urban segregation, especially in the case of large, run-down residential areas having disadvantageous location from urban structure aspects and located at the city outskirts. A primary condition for increasing the labour market opportunities of the inhabitants of these areas is effective and affordable city transport. In order to strengthen positive social effects, a tariff system can be established that prefers certain social groups (students, retired, families, and people with disabilities). Preference can be focused on certain groups or age groups (especially if the related price supplementation and loss financing is settled), but can be time-limited or time-based, as well. So, given seasonal conditions are valid for certain groups, e.g. discount can be offered during trips beyond peak hours, group discounts, ensuring the travelling of several persons in a period characterised by entitlement, etc. These tariff systems operate in a number of cities, in a transport association or within a tariff community system.

In order to optimise individual transport directed to the inner areas of cities, causing problems from environmental and traffic aspects, the introduction of various entry fees, tolls, and traffic restrictions can be proposed. This measure can concern – subject to the given model – those arriving from outside, or to a certain level those living within a given fee-zone. In the case of those living within the zone, they only pay when crossing the zone border (just like those arriving from outside), otherwise they can move freely within the zone. If internal movements are subject to fees (see London), preferences can be ensured for those living within, assuming the related political will of the city exists. When setting the entry fees, decision-makers have to take into consideration that all these kinds of restrictions are automatically discriminative for automobile users of lower financial means and higher entry fees are less affordable for poorer groups. A special form of entry fees is when the tariff depends on the environmental parameters of the given vehicle and the less the vehicle load is on the environment, the lower the fee will be. However, an automobile with lower emission level is mostly younger, more modern, and more expensive. Entry fee based on environmental attributes therefore intensively place a burden on social groups with lower financial means as they typically own old cars. This fact, in our opinion, does not require the introduction of equalizing mechanisms considering that the aim is to keep down entry to the lowest possible level and further reduction of the entry of the most polluting vehicles. If the level of community transport is adequate or optimized individual transport methods (car-sharing, car-pooling) and community bicycle systems are available, then the adequate and sustainable alternative of entry based on individual transport will be established.

In many cases a parallel is drawn between the introduction of parking fees and parking systems and the entry fee, when considering the restriction of automobile end traffic. In the former case those living in the zone are given preference as they are entitled to free or low-tariff parking (in certain cities free or preference entry). These restrictions therefore in principle should not have negative effect on the inhabitants of the zone; on the contrary, they should result in positive impact since the liveability of their residential area is improved as a consequence of the restrictions. Establishment of such traffic reduction systems however requires careful planning from the aspect of the zone inhabitants, as well. If the systems are too restrictive, parking places for exclusive use are few and entry fee is high, then inner cities and residential areas may become valueless and these city areas may tend to become slum-like.

13.2. SETTLEMENT ENERGY MANAGEMENT

The most significant energy-efficiency measures mobilizing citizens' sources can be found under the issue of settlement energy management. Energy consumption of residential units amount to 30-40% of total energy consumption, therefore the energy modernization of dwellings can produce significant reserves for the purposes of climate policy. Energy-efficient modernization of buildings moreover reduces operational costs, and thus the currently high rate of utility costs compared to income may be reduced (where currently it is about 30-50%) for the social strata in danger of poverty, thereby reducing the volume of arrears. A phenomenon can be observed in certain countries of Central Eastern Europe that due to accumulating arrears owing to the high utility cost, tens of thousands of families are forced to sell their real estate and buy cheaper properties further away from the city. Through this, they involuntarily get further from workplaces and good-quality public services (poverty suburbanization). These negative impacts could be reduced by making dwellings more affordable.

Modernization of buildings, however, requires significant investment, the return of which – depending on a number of parameters – may be realized only decades later. Not all social strata can undertake the expenses of such investments. At best, they can be assisted by an adequate support system. Considering social aspects, principally the establishment of those constructions to be supported that finance the investment by savings originating from energy-efficient renovation. Credit constructions are the ones that are capable of harmonizing the process running in two time dimensions, however it is important, how exposed the dwelling communities are to the credit institutions, and under what conditions do they have access to credit, especially when considering dwelling houses with poor solvency located in slum areas. Local governments may have a role in establishing coordination mechanisms that help in harmonizing the interests of dwelling communities struggling with a lack of information and banks.

Antwerp, targeted energy-efficiency support system

Antwerp is a port-town of 460,000 inhabitants in the north of Belgium, the capital of Antwerp province.

In compliance with the Kyoto Convention, the city of Antwerp committed to achieve a 7.5% reduction in the energy consumption of the city by 2012. Therefore, in 2005 in order to promote energy-efficiency investments, the City Council adopted a new support scheme focusing declaredly on owners with low apartment value and making them interested in these investments. The supported investment activities are the following:

- Extra insulation for existing windows (in the value of 20 EUR/m^2; max. U= 1.3 W/m^2K).
- Roof insulation (5 EUR/m^2, minimally in a value of R= 3m^2K/w).

In order to reach the target audience, the local government applied the following information tools:

- Circulation of special publications on environment protection and energy efficiency (3 times per year).
- Local magazine ‘De(n) Antwerpenaar’ (twice per month).
- Information page on the local government’s web site.
- Information packages delivered throughout the city.
- Information points at the waste collection stations available in the city.
- Organization of ‘Energy Week’ (information, exhibition, actions).
- Creation of green number for the inhabitants.
- Organization of press conference.

Information is provided beside the above-mentioned tools by information centres. The centres assist in filling in the application forms, as well. The sum available for the support – ensured by the city and one of its non-profit organizations: vzw Recyclant – increased in every year, from 90,000 EUR in 2005 to 260,000 EUR in 2009. In the course of the two years of the project, the aggregate surface of the roofs insulated grew from 929 m^2 to 5,763 m^2; the extent of window surface fitted with extra insulation grew from 1,396 m^2 to 5,169 m^2. The total value of the support amounted to 30,316 EUR in 2005, 75,591 EUR in 2006 and 119,205 EUR in 2007.

The support granted by the city served as a supplement beside the state tax refund system and the benefits of energy providers, thus giving the small impetus, by which the return period concerning energy-efficiency investments reduced significantly.

Contact:
Vzw Recyclant
Phone: 03-222 37 00
E-mail: filip.lenders@stad.antwerpen.be

An increasing percentage of dwellings are being renovated in Europe year by year. This fact can, at the same time, result in the weakening segregation or strengthening segregation of the dwelling. Renovation actually has direct effects on the real estate value: a renovated dwelling with lower operational costs is valued higher on the market and can revalue its direct environment, as well.

Renovation of more dwellings in turn can moderate the slum characteristic of the run-down districts and stop the spiral of poorer families moving in. At the same time, during that dynamism of renovations, the buildings where no energy-efficiency measures have taken place are significantly devalued. Communities of multi-family blocks not adequately disposing of financial resources (or organizational capacities), therefore can book further losses. The danger of this phenomenon is especially great in countries where multi-apartment buildings are in private ownership and operate as condominiums. Thus even owners in the minority with low solvency can make renovation impossible and speed up the segregation spiral. It would be possible to establish a local support scheme that would provide assistance, not to the whole dwelling community, but only to the resources of the households in need. However, this solution can incur high administration costs and cannot be properly applied in several countries of the European Union since, due to the grey economy and hidden income, the real income of households cannot be determined accurately. Nevertheless, we can find a good example for the introduction of supplementary support of households in need in Budapest, Hungary. The support by the Budapest City Rehabilitation Frame to apartment buildings provides extra assistance to families receiving certain types of regular social aid. Therefore, households only have to prove that they are granted the given social aid, which results in the significant reduction of administration costs.

Using certain types of renewable energy resources (e.g. solar collectors, geothermic energy) leads to similar results in case of dwellings and the renovation of them. The long run results in lower energy costs, but the short run requires investment. Therefore, the social (outplacing) effects of using renewable energy resources largely depend on what type of support system joins their application. The mass spreading of renewable energy resources raises further affordability issues, insofar as the compulsory take-over of energy produced at high prices (e.g. wind energy) raises average energy prices, which has a negative impact on the social strata with less income.

Application of environmentally friendly heating methods, e.g. district heating in a wide range also raises affordability problems since this heating method is one of the most expensive of the possible urban heating systems in many European countries. The spread of district heating in many countries have affordability, not technical, obstacles. Therefore nowadays, not the extension, but the detachment of district heating systems is a characteristic of Central and Eastern European cities.

13.3. ENERGY CERTIFICATES

Energy requirements to be applied for new constructions are becoming even more stringent, both on a community and national level. (Since 2006 the system of energy certification is to be applied in all Member States in accordance with Directive No. 2002/91/EC.) However, dwellings compliant with higher technical requirements can only be installed at a higher cost level, which automatically has an exclusion effect from of poorer social strata: population with lower purchasing power can drift even further from the new apartment market.

The system of energy certification to be applied at the sale and rental of used apartments is expected to be integrated into the real estate market. Thus, the energetic parameters of a building will become price formulating factors – of course, this has been true already for the basic energy parameters. Through detailed assessment, such characteristics will become part of the price formulation that has been more or less hidden so far, and the correction of which requires investments. In case of buildings inhabited by less well-off people, and having worse energy characteristics, a new market valuation aspect can further weaken the position of part of the apartments, which will inevitably lead to the strengthening of the segregation processes.

13.4. WATER MANAGEMENT AND COMMUNAL INFRASTRUCTURE

Concerning the area of communal infrastructure, proposals that may eventually have social impacts as well are aiming at broadening separate waste collection and the processing of waste, furthermore the extension of sewage networks and wastewater treatment.

In our view, the first topic – separate waste collection – implies basically positive social impacts from several aspects. On the one hand, by selecting recyclable waste the volume of communal waste is reduced, which can lower waste shipment costs. On the other hand, separate collection and processing of waste requires a generally low qualified labour force, which can assist people living in deep poverty facing difficulties in finding a job. On the whole, it can be said that a 'green economy' can provide real employment solutions for social groups with low status and low qualifications, as opposed to IT or other service industries requiring high qualifications which are defined as a breakthrough point and cited so many times nowadays.

At the same time, social impacts of separate collection of waste go beyond its economic aspects. The process of selective collection is one of the most efficient educational tools towards more environmentally conscious behaviour both among children and adults. With the help of the spectacular process of separate collection, receptivity to other aspects of environmental issues will grow as well.

Extension of sewage networks and wastewater treatment capacities (and the utilization of the resulting sludge) is a measure to be supported from environmental aspects without any doubt; however the investment costs – reduced by eventual support – are integrated into the waste water fee and can result in its very significant increase. The increased waste water fee then can lead to the accumulation of overdue fees or to the refusal of hooking to the network, thereby to the further reduction of the number of people bearing the fixed costs.

Generally speaking, environmental security concerns all players and all areas of society. In any area of application solutions, one must pursue the maintenance and intensification of security, since we have to prepare for a new and continuously changing system of environmental conditions. The state or the local government can take over the costs of these only partially, therefore the spreading of property insurance becomes necessary. Property differences will appear sharply right from this aspect and will somewhat intensify, since the most needy will have less possibilities to prevent the damage.

APPENDIX: INFORMATION BASIS OF URBAN CLIMATE PROTECTION AND ADAPTATION ISSUES

I. LIST OF INTERNATIONAL REGULATIONS, RECOMMENDATIONS, AND GUIDELINES

Environmental problems and thinking of their resolution appeared in the European community as early as 1973, just after one year of the first United Nations Conference on the Environment in Stockholm. Since then, environmental issues have been becoming more and more articulated. Environment protection got the status as a common horizontal policy by approving the Single European Act in 1986. Beside action programmes and strategies, more than 300 related legislation materials have been worked out in the EU.

Prevention became the main principle of environmental policy due to the third environmental action programme of the EU. Climate change aspects – mitigation and adaptation – have got priority since the '90s. The sixth environmental action programme deals with climate change.

As action against climate change is a top priority for the EU, it is not surprising that EU supported the two fundamental United Nations climate treaties on reducing CO_2 emission: the UN Framework Convention on Climate Change (UNFCCC) in 1992 and the Kyoto Protocol in 1997. According to Kyoto Protocol, the 15 EU member countries have aimed at reducing their collective emission in the period of 2008-2012 by 8% below 1990 levels. Moreover, in 2007 EU leaders made a commitment that Europe would cut its emissions by at least 20% of 1990 level by 2020. In this manner Europe could be transformed into a highly energy-efficient and low carbon emission economy.

Climate issues are also an essential part of the current development strategy of the EU, the so called EU2020. EU2020 sets up explicit climate protection targets (Target 3, the climate and energy target of '20/20/20' on cutting greenhouse gas emission, increasing energy efficiency, and supplying energy needs from renewable sources has a direct relation to cities, as focal sites of energy emission and consumption) and other related targets that are in a close connection with the strategy's sustainable and green economic development initiatives.

The following list summarizes the climate relevant EU legislations:

Directives and Decisions of European Parliament and of the Council

- Council Decision of 24 June 1993 for a monitoring mechanism of Community CO_2 and other greenhouse gas emissions, 1993
- 93/361/EEC: Council Decision of 17 May 1993 on the accession of the Community to the Protocol to the 1979 Geneva Convention on long-range transboundary air pollution concerning the control of emissions of nitrogen oxides or their transboundary fluxes

- Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control
- Resolution on the Communication from the Commission Energy for the future: renewable sources of energy: Green Paper for a Community strategy' (COM(96)0576 C4-0623/96)
- Communication from the Commission energy for the future renewable sources of energy : White Paper for a Community Strategy and Action Plan (COM(97)599 final) (26/11/1997)
- Directive 98/69/EC of the European Parliament and of the Council of 13 October 1998 relating to measures to be taken against air pollution by emissions from motor vehicles and amending Council Directive 70/220/EEC
- White Paper on environmental liability COM(2000) 66 final
- Communication from the commission on EU policies and measures to reduce greenhouse gas emissions: Towards a European Climate Change Programme (ECCP) COM(2000)88
- Green Paper on greenhouse gas emissions trading within the European Union COM(2000)87
- Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment
- Community activities in the urban environment – Cooperation to promote sustainable urban development (decision 1411/2001/EC)
- Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants
- Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions on the implementation of the Community Strategy and Action Plan on Renewable Energy Sources (1998 – 2000) (COM/2001/0069 final)
- Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market
- 2002/358/EC: Council Decision of 25 April 2002 concerning the approval, on behalf of the European Community, of the Kyoto Protocol to the United Nations Framework Convention on Climate Change and the joint fulfilment of commitments thereunder
- Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings. (Energy Performance of Buildings Directive – EPBD)
- Climate Change in the context of development cooperation (COM(2003) 85)
- Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC
- Decision No 280/2004/EC of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol
- Directive 2004/101/EC of the European Parliament and of the Council of 27 October 2004 amending Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community, in respect of the Kyoto Protocol's project mechanisms (Text with EEA relevance)
- 2004/192/EC: Commission Decision of 25 February 2004 adopting the work plan for 2004 for the implementation of the programme of Community action in the field of public health (2003 to 2008), including the annual work programme for grants
- 2005/166/EC: Commission Decision of 10 February 2005 laying down rules implementing Decision No 280/2004/EC of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol (notified under document number C(2005) 247)
- 2005/381/EC: Commission Decision of 4 May 2005 establishing a questionnaire for reporting on the application of Directive 2003/87/EC of the European Parliament and of the Council establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC (notified under document number C(2005) 1359)
- Communication from the Commission to the Council and the European Parliament (2006) on Thematic strategy on the urban environment; COM(2005)718, pp12

- Green Paper on energy efficiency (2005)
- Communication: Winning the battle against climate change. COM(2005) 35 final
- Commission Green Paper of 8 March 2006: ‘A European strategy for sustainable, competitive and secure energy’ (COM(2006) 105 final)
- Communication from the commission: Action Plan for Energy Efficiency: Realising the Potential (COM(2006)545 final)
- Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC
- 2006/780/EC: Commission Decision of 13 November 2006 on avoiding double counting of greenhouse gas emission reductions under the Community emissions trading scheme for project activities under the Kyoto Protocol pursuant to Directive 2003/87/EC of the European Parliament and of the Council (notified under document number C(2006) 5362)
- Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks
- Decision No 1350/2007/EC of the European Parliament and of the Council of 23 October 2007 establishing a second programme of Community action in the field of health (2008-13) (Text with EEA relevance)
- Commission of the European Communities: Green Paper from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions – Adapting to climate change in Europe – options for EU action (SEC(2007) 849)
- Commission of the European Communities: Green Paper – Towards a new culture for urban mobility, 2007 (COM(2007) 1209) 551
- Communication from the Commission to the Council, The European Parliament, the European Economic and Social Committee and the Committee of the Regions: Strategy on climate change: Limiting Global Climate Change to 2 degrees Celsius The way ahead for 2020 and beyond, 2007
- Communication from the Commission to the European Parliament and the Council, Addressing the challenge of water scarcity and droughts in the European Union; (SEC(2007) 993);
- Communication from the Commission to the European Council and the European Parliament an energy policy for Europe COM/2007/0001
- Commission staff working document – Limiting global climate change to 2 degrees Celsius – The way ahead for 2020 and beyond – Impact assessment summary (COM(2007) 2 final) (SEC(2007) 8)
- Commission Communication: The mid-term review of the Sixth Community Environment Action Programme COM(2007) 225
- Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe
- Commission of the European Communities: Regions 2020. Climate change challenges for European Regions, 2008
- Commission staff working document – Accompanying document to the proposal for a recast of the energy performance of buildings directive (2002/91/EC) – Summary of the impact assessment (COM(2008) 780 final) (SEC(2008) 2864)
- European Parliament resolution of 10 April 2008 on the Commission Green Paper on Adapting to climate change in Europe — options for EU action (COM(2007)0354)
- Commission White Paper of 23 October 2007 'Together for Health: A Strategic Approach for the EU 2008-2013' (COM(2007) 630 final)
- Commission Regulation (EC) No 245/2009 of 18 March 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for fluorescent lamps without integrated ballast, for high intensity discharge lamps, and for ballasts and luminaires able to operate such lamps, and repealing Directive 2000/55/EC of the European Parliament and of the Council
- Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community’s greenhouse gas emission reduction commitments up to 2020
- Commission of the European Communities: Commission Staff working document, Climate Change and Water, Coasts and Marine Issues; (COM(2009) 147 final)

- Commission of the European Communities Commission Staff working document: accompanying the White paper Adapting to climate change: Towards a European framework for action, impact assessment COM(2009) 147 final)
- Commission of the European Communities: White Paper Adapting to climate change: Towards a European framework for action, COM(2009) 147
- Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC
- Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Action Plan on Urban Mobility (SEC(2009) 1211) (SEC(2009) 1212)
- Commission Staff Working Document Accompanying document to the WHITE PAPER Adapting to climate change: Towards a European framework for action Human, Animal and Plant Health Impacts of Climate Change; (COM(2009) 147 final)
- Communication from the Commission (2009): Fifth National Communication from the European Community Under the un Framework Convention on Climate Change (UNFCCC) (required under Article 12 of the United Nations Framework Convention on Climate Change) (EU)
- Regulation (EC) No 443/2009 of the European Parliament and of the Council of 23 April 2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO_2 emissions from light-duty vehicles
- 2010/2/: Commission Decision of 24 December 2009 determining, pursuant to Directive 2003/87/EC of the European Parliament and of the Council, a list of sectors and subsectors which are deemed to be exposed to a significant risk of carbon leakage (notified under document C(2009) 10251)
- 2010/384/: Commission Decision of 9 July 2010 on the Community-wide quantity of allowances to be issued under the EU Emission Trading Scheme for 2013 (notified under document C(2010) 4658)
- 2010/253/EU: Commission Recommendation of 28 April 2010 on the research joint programming initiative on Agriculture, food security and climate change
- Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings
- Communication from the Commission EUROPE 2020 A strategy for smart, sustainable and inclusive growth (COM(2010) 2020)
- Green Paper on Forest Protection and Information in the EU: Preparing forests for climate change SEC(2010)163 final

Climate related European urban policy documents

- Leipzig Charter on Sustainable European Cities, Agreed on the occasion of the Informal Ministerial Meeting on Urban Development and Territorial Cohesion Leipzig , 24 May 2007
- Toledo Informal Ministerial Meeting on Urban Development Declaration, Toledo, 22 June 2010
- EUROCITIES Declaration on Climate Change, June 2008
- Final statement by the ministers in charge of urban development, Marseille, 25 Nov 2008
- Bristol Accord Conclusions of Ministerial Informal on Sustainable Communities in Europe, Bristol, 6-7 Dec 2005
- Council for European Urbanism (2008): Oslo Declaration; 8 June 2009 – Climate Change and Urban Design

Conventions

- United Nations Framework Convention on Climate Change, UNFCCC, Rio de Janeiro, 1992
- Convention Concerning the Protection of the World Cultural and Natural Heritage, Paris, 1975
- Convention on Long-range Transboundary Air Pollution, Geneva, 1983
- Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, Basel, 1992

- The Convention on Wetlands of International Importance especially as Waterfowl Habitat (also known as the Ramsar Convention), Ramsar, 1975
- The Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects (PEEREA), 1994
- Convention on the Protection and Use of Transboundary Watercourses and International Lakes, Helsinki, 1996
- United Nations Convention to Combat Desertification in Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa, Paris, 1996
- United Nations Framework Convention on Climate Change (UNFCCC) and Kyoto Convention, 1997
- Convention on Environmental Impact Assessment in a Transboundary, Espoo, 1997
- Energy Charter Treaty, Lisbon, 1998
- Convention on the Transboundary Effects of Industrial Accidents, Helsinki, 2000
- Convention on Persistent Organic Pollutants, Stockholm, 2004
- 2004/259/EC: Council Decision of 19 February 2004 concerning the conclusion, on behalf of the European Community, of the Protocol to the 1979 Convention on Long Range Transboundary Air Pollution on Persistent Organic Pollutants

Environment Programmes

- United Nations Environment Program
- First European Climate Change Program (ECCP) 2000-2004
- Second European Climate Change Program (ECCP II), 2005
- Decision No Decision No 1600/2002/EC of the European Parliament and of the Council laying down the Sixth Community Environment Action Program, 2002-2012
- EU Adopts Energy, Climate Change Package, 2009

Recommendations

- Council Resolution of 8 June 1998 on renewable sources of energy (98/C 198/01)
- Progress reports submitted by the Commission to the European Parliament and to the Council about inventories of GHGs, in order to monitor community GHG emissions, UNFCCC)
- European Parliament resolution on the EU strategy for the Nairobi Conference on Climate Change (COP 12 and COP/MOP 2), 2006
- Outlook opinion of the Committee of the Regions on 'How regions contribute to achieving European climate change and energy goals, with a special focus on the covenant of mayors' (2009/C 76/04)
- European Parliament resolution of 23 April 2009 on addressing the challenges of deforestation and forest degradation to tackle climate change and biodiversity loss
- European Parliament resolution of 4 February 2009 on '2050: The future begins today – Recommendations for the EU's future integrated policy on climate change' (2008/2105(INI))
- Joint EEA-JRC-WHO Report: Impacts of Europe's changing climate – 2008 indicator based assessment

II. SOME OF THE EUROPEAN KNOWLEDGE AND INFORMATION NETWORKS AND ORGANISATIONS ACTIVE IN URBAN CLIMATE PROTECTION AND ADAPTATION TO CLIMATE CHANGES

Covenant of Mayors

The membership of the Covenant of Mayors is composed of 1936 town and megapolises. These settlements would like to contribute to the reduction of CO_2 emission, increased energy efficiency, clearer energy generation, and consumption by the help of their political goals in conformity with the energy policy of the European Union. They made a covenant to reduce their CO_2 emission by at least 20% by 2020 through the implementation of their SEAPs (SEAP – Sustainable Energy Action Plan). According to this, they shall elaborate an urban structure in which the necessary tasks can be executed. In addition to this, they shall also mobilise the civil society to participate in the elaboration of the action plan. Other tasks: organising local 'Energy days', sharing of experiences, etc.

Contact:
Covenant of Mayors Office, 1 Square de Meeûs, 1000-Brussels (Belgium)
Helpdesk on general inquiries: +32 2 504 7862
Helpdesk on technical and scientific inquiries: +39 0332 78 3599
Media Desk: +32 2 340 3067 or +32 2 552 0851

ICLEI (Local Governments for Sustainability)
The 'International Council for Local Environmental Initiatives' (ICLEI) was established in 1990. Its membership of 200 municipalities (local governments) covers 43 countries. The participating municipalities oblige the companies operating within their boundaries to implement developments aiming at sustainability, and carry various programmes and campaigns to this end. More than 1,048 towns in co-operation with several hundred local governments participate in these programmes. The Hungarian members of the organisation are the municipalities of Budapest, Miskolc and Tatabánya.

Contact:
www.iclei.org
If you want to get in touch with the organisation you can do it at the above central address. You can find the contact data of the regional offices on the website as well. They are as follows:

- **ICLEI World Secretariat**

ICLEI – Local Governments for Sustainability
World Secretariat Kaiser-Friedrich-Str. 7, 53113 Bonn, Germany
Phone: +49-228 / 97 62 99-00
Fax: +49-228 / 97 62 99-01
Email: Membership inquiries: membership@iclei.org
Media & Web inquiries: media@iclei.org
Climate inquiries: climate.centre@iclei.org
Events inquiries: training.centre@iclei.org
General inquiries: iclei@iclei.org

European Environment Agency (EEA)
The European Union adopted a decree ordering the establishment of the European Environment Agency, and the European Environment Information and Observation Network (Eionet), but it was proclaimed only in 1993. For the time being, 32 countries are members of the EEA. Its fundamental duty is to provide unbiased information, and to act as an information resource for the EU member states.
The information available to the EEA concerning climate change (data, indices, evaluations, and forecasts) focus on the trends in the emission of greenhouse gases, the vocational policies and measures, and the European actions to be made in response to the impacts of the climate change and the adaptation thereto. By the help of this data, the Agency contributes to the fulfilment in the EU of the commitments undertaken in the Kyoto Protocol, evaluation of the environmental policies of the EU, mitigation of the climate change, and elaboration of the long term strategy of adaptation

Contact:
Kongens Nytorv 6, DK
1050 Copenhagen K, Denmark
Phone: +45 3336 7100

EUROCITIES
The EUROCITIES is the network of major European cities which was founded in 1986 by mayors from six large European cities: Barcelona, Birmingham, Frankfurt, Lyon, Milan and Rotterdam. Nowadays it brings together local governments of more than 140 large cities in over 30 European countries. The network influences and works with the EU institutions to respond to common issues that impact the day-to-day lives of Europeans. Their aim is to shape the opinion of stakeholders in Brussels to

ultimately shift legislation in a way that helps city governments to address the EU's strategic challenges at the local level.

Contact:
www.eurocities.eu/main.php
1 Square de Meeûs, B-1000 BRUSSELS
Phone: +32 2 552 08 88
Fax: +32 2 552 08 89
E-mail: info@eurocities.eu

Carbon Dioxide Knowledge Sharing Network (CO_2NET)
CO_2NET is a thematic European network established with a view to secure safe, reliable, sustainable, and climate-friendly European energy supply. More than 30 mammoth companies are its members throughout Europe, but also have companies from America and Australia. The main goal of the network is to inform and train the decision makers and others, and making the separation of the CO_2 emitted and its durable filling into the crust, that is CCS technology – emitting and storing) more familiar. This procedure is a technically viable and a socially acceptable opportunity for reducing the emission of greenhouse gases to a considerable extent. It is a key element in establishing sustainable energy systems in conformity with what has been set down in the Kyoto Treaty. Achievement will produce an even greater emission reduction. The most successful programme was accomplished between 2006 and 2008 and still continues.

Contact:
www.co2net.eu/public/brochures/CO2NET-Public-Brochure-Hungarian.pdf
www.co2net.eu

Climate Action Network – Europe (CAN)
Climate Action Network (CAN) is a global network uniting approximately 500 non-governmental organisations which, through governmental and other measures, contribute to the ecological sustainability of climate change caused by mankind. Their goal is that by the help of information exchange and harmonised developments international, regional, and national strategies elaborated to reduce emission can be executed. The network has seven regional offices worldwide. They focus on healthy environment and sustainable development. A central idea and goal of the network is to protect the atmosphere and, simultaneously, to contribute to sustainable, just and equitable development worldwide. It is the leading network in Europe dealing with climate and energy issues. It has 129 members in 25 European countries. The goal of its members is to prevent hazardous climate change and to support sustainable energy and environmental policies in Europe. It authorises the civil organisations and also supports them in elaborating such efficient global strategies, which can contribute to sustainable development both on the international and the local scale through the reduction of the emission of greenhouse gases.

Contact:
www.climnet.org (CAN-Europe)
Mundo B Rue d'Edimbourg 26
1050 Brussels, Belgium

URBACT (Urban Actions)
The URBACT Programme was launched in 2002 by the European Union. It is a programme facilitating education and the exchange of experiences with the goal to support sustainable urban development. The programme makes the megapolises capable of jointly elaborating solutions for the major urban challenges, and to strengthen the social role of towns facing more complex social changes. URBACT helps the towns in elaborating new and sustainable practical solutions which integrate the economic, social and environmental dimensions. URBACT makes it possible for towns to share throughout

Europe and show the best practical examples, experiences with all experts involved in urban policy. URBACT embraces 255 towns, 29 countries and 5,000 active participants.

Contact:
Phone: + 33 1 49 17 46 02
Fax: + 33 1 49 17 45 55
194, av. du Président Wilson
93217 Saint-Denis La Plaine Cedex, France
www.urbact.eu

Energie-Cités
Energie-Cités is an organisation uniting local European experts and supporting the sustainable local energy trends. The association was established in 1990 in more than 1,000 towns of 26 countries. For the time being, its Presidency is in Heidelberg (Germany) but it has Directorates in 11 other towns (Bielsko-Biała, Braşov, Cork County, Delft, Heidelberg, Helsinki, Leicester, Pamplona, Paris, Salerno, Växjö), as well. Their main targets are to strengthen the role played by sustainable energy and make motions to the European Union in the fields of energy, environmental protection, urban policy, and to facilitate the various initiatives and exchanges of experiences.

Contact:
www.energie-cites.eu/-ABOUT-1, square de Meeûs
BE-1000 Bruxelles
Phone: +32 (0)2 504 78 60
Fax: +32 (0)2 504 78 61
Main office: +33 3 81 65 36 80
Bruxelles office: +32 2 504 78 60

Resilient City
The Resilient City Association unites architects, urban planners, engineers and landscape architects whose goal is to elaborate creative, practical, and feasible plans and building strategies. By these, they want to contribute to getting prepared for the most important challenges of our century, namely, problems which can essentially manifest themselves in the future, among them; the effects of climate change and the energy problems caused by mankind. They publish these strategies on their website. Their fundamental mission is to increase awareness, first and foremost, by collecting studies, research materials, and to introduce such changes in the fields of planning and fulfilment as the capabilities of towns increase and they become able to adapt themselves to the economic, social and cultural impacts of energy and climate change.

Contact:
www.resilientcity.org

Climate Alliance / Klimabündnis
Climate Alliance was established in 1990. Currently, more than 1,500 European towns are its members from 17 European countries. The organisational structure and its influence are the strongest among German-speakers in Italy and Spain.
The towns participating in the Alliance commit themselves to a sustainable and climate-friendly urban development. In order to facilitate its achievement, the Climate Alliance makes regular exchanges of experiences in the form of conferences, by operating an internet platform, and organising joint projects. The Climate Alliance assists the towns participating or wishing to participate in its work and wishing to achieve their climate friendly goals, by regular consulting, recommendations as to the action plants they adopt, and the evaluation of the impacts of interventions on the participants' level. The centre of the Climate Alliance is in Frankfurt am Main, but in order to facilitate contact and coordination it has contact points in several countries.

Contact:
Climate Alliance / Klimabündnis / Alianza del Clima e.V.
Galvanistr. 28. D-60486 Frankfurt am Main
Phone: (49) 69 717139 0
Fax: (49) 69 717139 93
E-mail: europe@klimabuendnis.org
www.klimabuendnis.org

European Urban Knowledge Network (EUKN)

The European Urban Knowledge Network is aimed at sharing urban knowledge and practices. It has been initiated by seventeen EU member states, the EUROCITIES network, the URBACT Programme, and the European Committee. Its primary goal is to share urban knowledge (theoretical, strategic and concrete development experiences) with the European community of professionals and to create such connections between the European towns that would contribute to their sustainable development. The Network was established in 2005 by fifteen European states with the consent of their ministers responsible for urban planning. Currently, towns of seventeen EU member states participate and, besides the member states and based on the initiative of the European Commission, also EUROCITIES and URBACT take part. The basis of the work of EUKN is the electronic library, which collects knowledge on urban development based on the uniform quality standards and norms regulating contents. In the monthly average more than 90,000 visitors read the 5,000 items — case studies, strategies and analyses — stored in this library.

Contact:
www.eukn.org
www.eukn.hu

Transition Network

In response to the twin pressures of Peak Oil and Climate Change, some pioneering communities in the UK, Ireland and beyond are taking an integrated and inclusive approach to reduce their carbon footprint and increase their ability to withstand the fundamental shift that will accompany Peak Oil. Transition model is a loose set of realworld principles and practices that have been built up over time though experimentation and observation of communities as they drive forward to build local resilience and reduce carbon emissions.

Transition Network is a charity formed to build upon the groundbreaking work done by Kinsale (Ireland), Totnes (UK) and the other early adopters of the Transition model. Their mission is to inspire, inform, support, network and train communities as they consider, adopt and implement a Transition Initiative. They are building a range of materials, training courses, events, tools & techniques, resources and a general support capability to help these communities. Till March 2011, 362 official transition initiatives registered from all around the world.

Contact:
www.transitionnetwork.org

Cittaslow

The movement was launched in 1999 by Paolo Saturnini, the mayor of Greve of Chinati, a township in Toscana, and the criterion system consisting of 55 points was elaborated in Orvieto. The term ‘slow city’ is to cover the creation of re-humanised, viable environmental conditions that are more correct from an ecologic point of view, reconsidering of the production of local foods and the relations of the settlement, renaissance of the public places (fora). The criteria outline the picture of a town which cannot have a population in excess of 50,000 people provides for the mitigation of the load from the traffic and noise, has a higher ratio of green surfaces, prefers locally manufactured products, keeps its traditions alive, has high-quality public spaces, theatres, shops, restaurant, historical monuments and unspoiled landscape. At the moment the movement has 125 members in Italy, Austria, Australia, United Kingdom, Germany, Norway, the Netherlands, Spain, Sweden, Switzerland, Poland, Republic of Korea, the USA and Canada.

Contact:
www.cittaslow.org
www.cittaslow.org.uk

Large Cities Climate Leadership Group (C40 cities)
This organisation was established in October 2005, when the heads of 18 megapolises met in London to discuss the impacts of global warming and climate change and to cooperate to handle them. They made a promise, evidenced by their signatures, that in the future they shall cooperate to reduce the emission of greenhouse gases and to improve energy efficiency. At the moment, 40 towns are the members of this organisation and 19 are on the list of those who wish to join. The members launched a website which shows the climate strategies of several selected towns, and a number of practical examples are shown (ideas in connection with buildings, energy, water, the various types of waste and lighting), that can contribute to the achievement of the above goals.

Contact:
www.c40cities.org

III. INDICATOR KITS: OPTIONS TO MEASURE URBAN CLIMATE CHANGE AND INTERVENTION

The goal of the following indices is to characterise the impacts of climate change, and the goals and measures aiming their mitigation in an objective, measureable and valuable manner. The various indices shall be applied at various levels ranging from international to local, and must comply with different requirements and criteria. The goal of the creation of these indices and the way how they approach the problems can be quite different. Their applicability, sensitivity (changeability), reliability and measurability can be different too. This is especially true for the complex indicator, which, as a rule, contains information on several disciplines which are interrelated with each other only at certain points. Nowadays all and more such indices are defined; their use entails a continuously and dynamically developing methodology. Punctually for this reason, we did not attempt to give a comprehensive introduction. Instead, we attempted to present only the most well-known and widespread indexes. Based on the above, there are several uncertainties in connection with their use, and based on one single indicator one cannot get a realistic picture, and the results shall not be certainly coherent if different data shall be used. With proper care, however they can be a very useful tool and render a direct help in the setting of tasks.

Compound Indexes

European Green City Index
In 2009, the Economist Intelligence Unit a research and consulting world organisation made a study surveying the environmental impacts of the megapolises of Europe. The Green City Index evaluated the performance of 30 leading European towns in 30 European countries in the field of environmental protection. The complex index takes into consideration 30 individual indices in the most divergent territories of environmental protection such as, for example, environmental management, water consumption, waste management, and greenhouse gas emission. The index characterises by a complex value each town and sets their ranking in 8 categories (CO_2, energy, buildings, transport, water, waste and land use, air quality and environmental management).

Source: www.siemens.com/entry/cc/en/urbanization.htm?section=green_index

The Germanwatch Global Climate Risk Index 2010
The global climate change risk index shows to what extent various countries are affected by events related to or caused by weather (storms, floods, and heat waves, etc.). The basis of the index is the

NatCatService database (data covering the period between 1990 and 2008) operated by the Munich Reinsurance Company. The index processes the most reliable socio-economic data available in connection with the extreme weather events but does not take into account the increase of the sea-level and the melting of glaciers. The index makes a warning forecast for each country regarding what new exposure and injury is expectable in the given place due to extreme circumstances compared to what had to be faced there before. The indirect climatic effects (e.g., heat waves) can cause much more unfavourable direct impacts (food shortage, and drought). The less developed countries are much more affected by the harmful effects and extreme weather conditions that may be caused by climate change.

Source: www.germanwatch.org/presse/2009-12-08e.htm

Building an Environmental Quality Index for a Big City

Munich Personal RePEc Archive is a company engaged in the coordination of reports, and vocational materials collected. One of the main topics of the study prepared by the company is the environmental quality index of buildings. This complex index has been prepared either as the linear combination of several indicators, or on the basis of the analysis of the main component and is interpreted spatially. Recommendations have been formulated according to the date and that architecture noise effects and air pollution should be studied. These characteristics can be described by subjective (statistical) and objective environmental variables (data obtained from the environmental measuring stations), and can be presented in the form of a complex environmental index containing social and economic correlations as well.

Source: mpra.ub.uni-muenchen.de/10736/1/MPRA_paper_10736.pdf

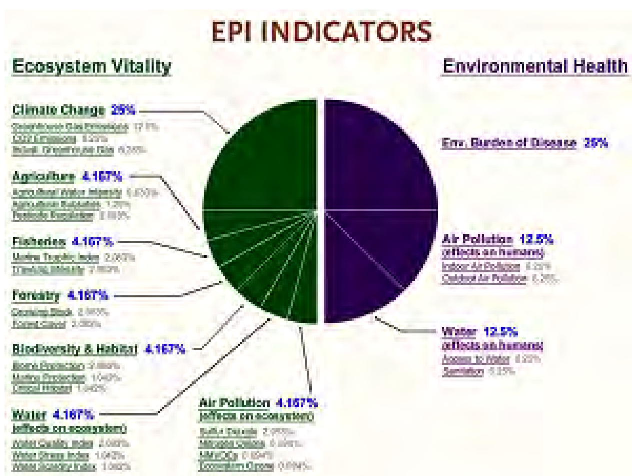
Global City Indexes Programme (GCIF indexes)

The goal of the programme is the elaboration of a web-based database whereby the life quality and the quality of the services of various cities can be compared. There are 22 themes in this database, among them environmental protection, energy, regional planning and health. These main topics are described by 94 indexes, of which 27 are basic, 26 auxiliary indexes and 41 deal with the future.

Source: www.cityindexes.org/Default.aspx

The 2010 Environmental Performance Index

The 2010 Environmental Performance Index (EPI) sets the rank of 163 countries on the basis of the Environmental Performance Index, which contains environmental and public health indices. For example, per capita emission of greenhouse gases, and ratio of woods, water shortage index, and number of threatened species are shown. This index helps confirm how close the established environmental policies of the various countries are to one another.



Source: www.greenfudge.org/2010/04/25/the-2010-environmental-performance-index-has-been-released epi.yale.edu

Environmental Disaster Risk Indexes

The Secretariat of International Strategy for Disaster Reduction (ISDR) of the UNO launched the Prevention web homepage in November 2005 for sharing its information basis on the mitigation of disaster risks for the experts but also for the public. The target audience of the homepage are basically local people who are furnished with information in this way on the main disaster territories and the mitigation of the extent of disaster. On the Prevention web homepage, one can find the risks, hazards of the natural disasters (tropic cyclones, floods, landslides, tidal waves, droughts) for several countries. The disaster risk index includes the probability of these events and their negative impacts, as well. The index also contains the number of people living in the exposed territory, the number of events, and the potential GDP fall.

Source:
www.preventionweb.net/english/countries/europe/hun/?x=10&y=8
www.preventionweb.net/files/11775_UNISDRBriefingAdaptationtoClimateCh.pdf

Ecological Footprint and Ecological Deficit
The ecological footprint measures the size of territory occupied by mankind, a nation, or certain social groups from the Earth surface for their sustenance, or on which they have direct impacts. These territories are the ones from where the resources (food, energy, etc.) necessary for maintaining human life originate, and where these can be grown without damage. Based on these, the following types of territories have been set:
- arable land (secure foodstuffs, fodder, fibres and oil);
- pastures (people use the meat, skin, wool and milk of the grazing animals);
- fisheries (fish and sea food come from there);
- woods (provide wood, wood fibre and firewood);
- carbon-absorbing regions, e.g., forests (required for binding CO_2 emitted as a result of the combustion of fossil fuels (coal, natural gas and oil));
- nuclear energy equivalent (the area which is required to bind the same quantity of CO_2 emitted as a result of the combustion of fossil fuels);
- constructed Earth surface occupied by infrastructure (roads, buildings, water power stations, etc.).

The ecological deficit is the difference between the actual available ecologically productive territory and the ecological footprint. The dependence index shows at what rate the economic and social existence of a region relies on local resources and at what rate it relies on the imported materials and energy. The examined components are: indices related to the management of local water resources and water supply, territory of soil per capita used for agricultural production as against non-productive territories (forests, natural conservation areas, where no agricultural activities are carried on), breakdown of all of the employed of the local community as per place of employment, breakdown of the budget of the municipality in terms of internal and external revenues, and the participation of the municipality and private owners in the public utilities.

Statistical indices and indicators

	Name of indicator	Measurement unit	Chapters
1	Annual winter and summer medium temperature and its changes	°C	1.2. Consequences of the climate change in European regions
2	Annual winter and summer rainfall quantity and its changes	millimetre	
3	Change in the number of drought days	day	
4	Change in the number of freezing days	day	
5	Annual number of extreme rainfall events	case	
6	Change of the groundwater level	cm	
7	Annual number of days with snow cover	day	
8	Frequency of showers	case/annum	
9	Frequency of hail	case/annum	
10	Highest absolute temperature of the year	°C	
11	Lowest absolute temperature of the year	°C	
12	Largest annual amount of rainfall	mm	
13	Smallest annual amount of rainfall	mm	
14	Highest amount of rainfall in 24 hours	mm	
15	Highest amount of rainfall in 60 minutes	mm	
16	Strongest blast of wind	m/s	
17	Annual number of snowy days	day	
18	Highest daily minimum temperature	°C	
19	Highest daily average wind speed	m/s	
20	Memberships in climate-aware networks and organisations	piece	2. Climate-friendly urban governance for forming economic and other urban policies
21	Number of climate-aware legislation and policy initiations	piece/annum	
22	Rate of green (climate-aware) public procurement actions	%	
23	Rate of public companies run by the city having climate-aware business policy	%	
24	Rate of divisions at the municipality having climate protection and adaptation tasks officially	%	
25	The total number of partners (individuals and organisations) in climate partnership initiations	piece	
26	Rate of local enterprises and firms taking part in climate partnership initiations	%	
27	Aims towards climate protection or climate adaptation at high decision making levels (policy level)	yes/no	3. Integrated strategic planning for climate-friendly cities
28	Rate of city plans and programmes incorporating principles on climate protection and adaptation to climate change	%	
29	Rate of strategic environmental assessments of the city's planning processes integrating the issue of climate change	%	
30	Number of involved partners (individuals and organisations) into climate planning actions	piece	
31	Housing density	person per hectare	
32	Height of buildings	floor	

	Name of indicator	Measurement unit	Chapters
33	The number of days on which in a three-year period (on rolling average) per annum measures had to be ordered concerning the information grade of the smog alert or the rate of alert.	day	4. Climate friendly urban structure
34	The size of covered/built in (biologically inactive) surfaces of the green areas compares to the total green area	%	
35	Change of the quantity of green areas (biologically active) in the past 5 (-10) years	%	
36	The size of green roofs	m^2	
37	The size of protected nature areas of local interest	ha	
38	Registered, protected species	piece	
39	The share of green areas and nature protection areas in the vicinity of larger than 500 m	%	
40	The amount of costs spent on the maintenance of protected nature areas of local interest	currency	
41	Number of parking lots established in order to improve access to nature protection areas	piece	
42	Forest density of the settlements	%	
43	Share of protected forests	%	
44	Area of public parks	ha	
45	Number of public parks	piece	
46	Total size of community parks and public spaces	ha	
47	Total size of green surface of public purpose	ha	
48	Green area per person	m^2/capita	
49	Aggregated green area cover of the settlement	%	
50	Share of domestic plants in public parks	%	
51	Share of strongly allergic plants in public parks	%	
52	Share of plants damaged from health point of view	%	
53	Total number or park objects	piece	
54	Number of park object service relaxation (benches, wells, lighting, waste bins) in public green areas	piece	
55	Number of playgrounds in public green areas	piece	
56	Number of sports facilities (sports courts, table tennis and chess tables, etc.) in public green areas	piece	
57	Visitors in public green areas	person	
58	Share of damaged plants as the result of vandalism	%	
59	Share of damaged park objects as the result of vandalism	%	
60	Number of venues held in public green areas in the vegetation period	case	
61	Change of the real values of amounts spent on the treatment of green areas	currency	
62	Number of persons participating in the maintenance/protection works of green areas	person	
63	Labour force expenditure falling on one unit of green area	work hour/m^2	
64	Size of areas drawn out of cultivation	ha	
65	Share of areas drawn out of cultivation	%	

	Name of indicator	Measurement unit	Chapters
66	Balance of land use	ha	4. Climate-friendly urban structure
67	Functional distribution of forest area	%	
68	Composition of forests by tree species	%	
69	Share of the trees, which are losing their leaves in the forest	%	
70	Number of park objects in the forest	piece	
71	Number of reported damaged caused by wild animals	case	
72	Number of reported damage caused by storms	case	
73	Number of reported forest fires	case	
74	Number of surveyed brown field areas	piece	
75	Size of surveyed brown field areas	ha	
76	Number of surveyed areas to be mitigated separately in brown field areas in the landscape wounds	piece	
77	Size of surveyed areas to be mitigated separately in brown field areas in the landscape wounds	ha	
78	Number of mitigated areas separately in brown field areas and landscape wounds	piece	
79	Size of areas mitigated from damages separately in brown field areas in the landscape wounds	ha	
80	Visitors in the forests	person	
81	Size of green areas established on brown field areas	ha	
82	Share of utilised brown field areas	%	
83	Number of constructed sports fields	piece	
84	Length of constructed running tracks	km	
85	Number and share of local, landscape-specified products with trade mark	piece, %	
86	Number of heritage inventories of the settlement	piece	
87	Number of historical monuments under local protection	piece	
88	Number of buildings proposed for local protection	piece	
89	Number of world heritage area	piece	
90	Size of world heritage area	ha	
91	The amount spent on an annual basis for refurbishment and condition maintenance of protected buildings being managed by the settlement itself	currency	
92	The amount of funding intended to be spent by the town for the refurbishment of locally protected buildings	currency	
93	Quantity of waste collected from green areas	ton	
94	The number of excessing the limit value (100 μg/m^3) by the hour concerning nitrogen-dioxide pollution	piece	5. Climate friendly urban transport
95	The annual average concentration of PM10 (flowing dust with the diameter of 10 micrometre)	μg/m^3	
96	The number of excessing the limit value (100 μg/m^3) by the 24-hour concerning nitrogen-dioxide pollution	case	
97	Pollution by fine flowing dust (PM2.5)	μg/m^3	

	Name of indicator	Measurement unit	Chapters
98	Bicycle and pedestrian traffic in proportion of the local traffic	%	5. Climate friendly urban transport
99	Costs spent on the reduction of air pollution	currency	
100	Number of vehicles	piece	
101	Share of utilising bio-fuel for transportation purposes	%	
102	The distribution of passenger transportation	%	
103	Greenhouse gas emission of transportation	ton CO_2 equivalent	
104	The total amount of sold electrical energy; of this separately to the households	TWh	6. Low carbon nergy management of the settlement
105	Total gas sales of this separately to households	PJ	
106	Gas consumption per household costumers	GJ/household	
107	Greenhouse gas inventory of towns (CO_2, CH_4, N_2O emission and consolidation)	megaton/CO_2 equivalent	
108	Electricity production generated from primary energy carriers (e.g. agricultural products)	ton	
109	Primary energy generated from renewable energy source	ton oil equivalent	
110	The formation of the utilisation of renewable energy carriers	%	
111	Share of renewable energy in electricity generation	%	
112	Emission of greenhouse gases	ton CO_2 equivalent	
113	The sustainable heat energy demand of one apartment	kWh/m^2 annum	7. Climate-friendly architectural solutions
114	The sustainable electrical energy demand of one apartment	kWh/day	
115	Quantity of generated waste	l/capita	
116	Size of greening on facades	m	
117	Household water consumption/annum	m^3	
118	The share of dwellings with public sewerage	%	
119	District heating provided for households	PJ	
120	Average electricity consumption per household consumer	MWh/ household	
121	Average district heating consumption per household consumer	GJ/household	
122	Number of municipality institutions holding energy audit	U	
123	Temperature indicators of the heat island effect of the settlement	-	
124	Number of dwellings built	piece	
125	Share of dwellings built newly	%	
126	Share of the re-utilised construction waste	%	
127	Drinking water demand	l/capita	8. Adaptable water management and urban communal infrastructure
128	Rainwater demand	l/capita	
129	Proportion of selective waste collection	%	
130	Waste transported to landfills	ton/annum	
131	Valuation of under surface waters in compliance with the Directive of the Water Framework	-	
132	Valuation of surface waters in compliance with the Directive of the Water Framework	-	

	Name of indicator	Measurement unit	Chapters
133	Number of drinking water wells	piece	8. Adaptable water management and urban communal infrastructure
134	Distribution of water generating plant by water source	-	
135	Length of drinking public water network	km	
136	Drinking water production	m^3	
137	Quantity of provided water	m^3	
138	Total water consumption	m^3	
139	Length of public sewerage network	km	
140	Collected wastewater and rainwater	m^3	
141	The distribution of the treatment of collected water quantity among the wastewater treatment plants	m^3	
142	The share of biological and tertiary wastewater treatment	%	
143	Length of unified system of rainwater collection	km	
144	Length of separated system of rainwater collection	km	
145	Other rainwater collection solutions (thickening)	number of involved dwellings	
146	Open-trench rainwater collecting system	km	
147	Length of ditch system and small water flows	km	
148	The proportion of area keeping the rainwater on sport with surface drainage	%	
149	Existence of the quality control system of rainwater	-	
150	Application of rainwater utilisation systems	-	
151	Urban solid waste per capita	kg/capita	
152	Share of solid waste collected selectively	%	
153	Share of urban solid waste put in landfills	%	
154	Share of urban solid waste incinerated	%	
155	Share of the utilisation in the material of green and bio-waste	%	
156	Share of the utilisation of wastewater sludge	%	
157	Number of waste yards	piece	
158	Number of selective waste collection points	piece	
159	Surface and under-surface water abstraction	m^3/annum	
160	Share of people are connected to sewerage systems	%	
161	Share of the population living in areas provided with natural type of wastewater treatment	%	
162	Healthy life years and life expectancy at age 35, by type of settlement	year	9. Preparing for disaster management and health care
163	Number of bronchitis sicknesses	piece	
164	Healthy life years and life expectancy at birth	year	
165	Share of children struggling with chronic bronchitis and asthma illnesses	%	
166	Change of the air hygienic index, Number of days of 3rd and 4th grade	day	
167	Allergic species in public spaces covered with plants	piece/m^2	

	Name of indicator	Measurement unit	Chapters
168	The annual total pollen concentration of weeds	piece/m^3	9. Preparing for disaster management and health care
169	Monthly change of the total pollen concentration	piece/m^3	
170	Annual number of days with concentration of 30 pollen grade/m^3	day	
171	NO_2 pollution along bicycle roads	µg /m^3	
172	The quantity parameters of drinking water targeted for human use	mg/l	
173	The number of exceeds of limit values specified in the legal regulation in case of the individual pollutants	case	
174	Number of heat waves	day	
175	Number of heat days	day	
176	Number of additional deaths as the result of the heat waves	case	
177	Number of days of UV alarm	day	
178	Number of deaths due to freezing	case	
179	Number of deaths due to melanoma	case	
180	Number of detected and reported new melanoma cases per 10000 inhabitants	case	
181	The risk of the population by the atmosphere solid material emission	µg/m^3	
182	The risk of the population by ozone emission	µg/m^3	
183	Ageing index (60-x years/0-14 years)	%	
184	Number of health service centres operating at the settlements	piece	
185	Number of persons participating at training preparing for emergency situations (heat wave, flood)	person	
186	Existence of forecast or rioting system concerning emergency situations (storm surge, flood, heat wave)	yes/no	
187	Number of visitors in environment protection areas	person	10. Creation of climate-conscious attitude and lifestyle
188	Number of awareness and scientific dissemination programmes	piece	
189	Number of participants at awareness and scientific dissemination programmes	person	
190	Number of inhabitants achieved by shaping social attitudes of environment	1000 person	
191	Number of students at ecological schools	1000 person	
192	Number of employees participating in environment protection training in Mayor's offices and municipality institutions	person	
193	Average number of persons per dwelling	capita	11. Supporting deprived groups in adapting to climate change
194	Number of disabled people	person	
195	Share of persons receiving social support	%	
196	Share of persons living in poverty	%	
197	Funding provided for deprived groups for the purposes of energy efficiency and construction	currency	
198	Migration balance	person	
199	Flood control costs	currency	
200	Extent of flooded area	hectare	

	Name of indicator	Measurement unit	Chapters
201	Frequency of forest fires in the urban and suburban areas	piece/year	12. Economic effects and the enhancement of urban economy
202	Irrigation costs of the public parks, urban green areas	currency	
203	Changes in the average heating costs	currency	
204	Changes in the real estate prices	currency	
205	Ratio of products sold locally	%	
206	Amount of recycled waste	m^3	
207	Cost of road reconstruction	currency	
208	The number of factories producing alternative energy in the city	piece	
209	Number of factories producing environmentally friendly products	piece	
210	Number of factories applying green technology	piece	
211	Ratio of operating environmentally friendly enterprises	%	
212	The number of public workers at building renovations	person	
213	The city's environmental tax revenues	currency	
214	Public money spent on environmental protection	currency	
215	Changes in the length of tourist season	day	
216	The change in the number of guest nights spent in the city	piece	
217	Changes in tourism tax revenues	currency	

IV. GOOD PRACTICES OF URBAN CLIMATE EFFORTS – CONTRIBUTIONS OF EUROPEAN CITIES AND STATES

Good practices included in the handbook

	Best practice	Organisation	Country	City	Topic
1	MODEL project (Management Of Domains related to Energy in Local authorities)	Energy Cities	International	International	Settlement governance
2	London Climate Change Partnership		Great Britain	London	Settlement governance
3	Public procurement for environmentally friendly transportation	Madrid City Council	Spain	Madrid	Settlement governance
4	KLIMP (Climate Investment Programmes)	Swedish Government	Sweden	National level	Settlement governance
5	Finnish municipalities for the handling of climate change	Association of Finnish Local and Regional Authorities (AFLRA)	Finland	National level	Settlement governance
6	City of Madrid Plan for the Sustainable Use of Energy and Prevention of Climate Change	Madrid City Council	Spain	Madrid	Integrated strategic planning
7	Developing individual climate plans		France	Marseille	Integrated strategic planning
8	Integrated Urban Development Strategy		Hungary	National level	Integrated strategic planning
9	Climate Proof Adaptation Strategy	City of Rotterdam	Netherlands	Rotterdam	Integrated strategic planning
10	Regional Climate Change Plan and ECO2 Programme	City of Tampere	Finland	Tampere	Integrated strategic planning

	Best practice	Organisation	Country	City	Topic
11	Valladolid - III Action Plan of Local Agenda 21	City Council of Valladolid	Spain	Valladolid	Integrated strategic planning
12	GANG-group	GANG group	Hungary	Budapest	Urban structure
13	Green Ring	Geschäftsstelle Grüner Ring Leipzig c/o ISIP Weiterbildungsgesells chaft mbH	Germany	Leipzig	Urban structure
14	London 2012 project – brownfield investment	London Organising Committee for the Olympic Games	Great Britain	London	Urban structure
15	Urban farming	Dott 07	Great Britain	Middles-borough	Urban structure
16	A network for the cultivation around the city in France	Terres en Villes	France	National level	Urban structure
17	Urban regions		Netherlands	National level	Urban structure
18	Functional urban structure		Netherlands	Nijmegen	Urban structure
19	The city building towards indside' Hammarby Sjöstad (eco-district)	City of Stockholm / Glashus Ett	Sweden	Stockholm	Urban structure
20	Hammarby Sjöstad - A unique environmental project in Stockholm	City of Stockholm	Sweden	Stockholm	Urban structure
21	Light train	Veolia Transport Ireland Ltd	Ireland	Dublin	Transport
22	PEDIBUS	Magistrat der Landeshauptstadt Freistadt Eisenstadt	Austria	Eisenstadt	Transport
23	Route planner and CO_2 emission calculator	Helsinki Region Traffic Authority	Finland	Helsinki	Transport
24	Buses driven by biogas	Lille Metropole	France	Lille	Transport
25	Hybrid taxis	Rumeni Taxi	Slovenia	Ljubljana	Transport
26	Bicycle change network	City of Lyon	France	Lyon	Transport
27	Swiss Traffic Federation		Switzerland	National level	Transport
28	Traffic-calming	City of Nuremberg	Germany	Nuremberg	Transport
29	Promoting public and individual non-motorised transport in gaining ground	Trondheim municipality	Norway	Trondheim	Transport
30	Utilization of biogas discharging from waste water sludge	EYDAP-Akrokeramos Keratsiniou	Greece	Athens	Energetic
31	Biomass central heating plant	Pro EcoEnergia Ltd.	Bulgaria	Bansko	Energetic
32	Solar Thermal decree	Barcelona Local Energy Agency	Spain	Barcelona	Energetic
33	Modernization of public lighting	Municipality of Brasov – Office for Public Lighting	Romania	Brasov	Energetic
34	Establishment of the autonomic energy system	European Center of Renewable Energy Güssing GmbH	Austria	Güssing	Energetic
35	Geothermic district heating system	HVSZ Heating Servise Ltd.	Hungary	Hódmező-vásárhely	Energetic
36	Renewable Energy Sources (RES) Champions League	Renewable Energy Sources (RES) Champions League	European	International	Energetic
37	Biomass central heating plant	PEC Lubań Sp. z. o. o.	Poland	Lubań	Energetic
38	Low capacity hydropowers	Praterkraftwerk GmbH	Germany	Munich	Energetic
39	Auroralia	LUCI	European Award	National level	Energetic
40	Pico wave energy centre	Wave Energy Centre	Portugal	São Miguel	Energetic

	Best practice	Organisation	Country	City	Topic
41	Cogeneration power plan	Energie AG Oberösterreich Kraftwerke GmbH	Austria	Timelkam	Energetic
42	Solar energy utilization	Solarstiftung Ulm/Neu-Ulm	Germany	Ulm	Energetic
43	Establishment of a combined wind-hydrogen system	Hydro Oil & Energy – Utsira Project	Norway	Utsira	Energetic
44	Westmill Wind Farm project	Westmill Wind Farm Co-operative	Great Britain	Watchfield	Energetic
45	Monument protection after flood		Czech Republic	Cesky Krumlov	Architecture
46	Green roofs	City of Copenhagen, Technical and Environmental, Parks and Nature	Denmark	Copenhagen	Architecture
47	Passive school	Architekturbüro Raum und Bau GmbH	Germany	Dresden	Architecture
48	Scarlet Hotel- complex sustainable architectural solutions	Scarlet Hotel Ltd	Great Britain	Mawgan Porth	Architecture
49	Programme for improving energy efficiency in Slovakian households	Ministry of Transport, Construction and Regional Development	Slovakia	National level	Architecture
50	Construction consultancy and loans	EOS Group	Belgium	Ostend	Architecture
51	The first qualified passive house in Hungary	Intervallum Ltd.	Hungary	Szada	Architecture
52	Effects of climate change on the building stock		Hungary	Tatabánya	Architecture
53	A city quarter made of wood	City of Vaxjo	Sweden	Vaxjo	Architecture
54	Sustainable water management	County Council of Cambridgeshire	Great Britain	Cambourne	Water and communal infrastructure
55	Flood action plan of Greve	Municipality of Greve	Denmark	Greve	Water and communal infrastructure
56	Complex waste treatment	NSR AB	Sweden	Helsingborg	Water and communal infrastructure
57	Usage of sewage	Symboylio Apocheteyseon Larnakas (Larnaca Sewerage and Drainage Board)	Cyprus	Larnaca	Water and communal infrastructure
58	Thames Estuary 2100 project – Managing flood risk through London and the Thames estuary	Environment Agency	Great Britain	London	Water and communal infrastructure
59	Gómeznarro Park, Madrid, park refurbishment with storm water retention	Municipality of Madrid	Spain	Madrid	Water and communal infrastructure
60	Selective communal waste collection	Riudecanyes City Council	Spain	Riudecanyes	Water and communal infrastructure
61	Use of sewage in a nursery garden	Municipality of Halmstad, Technical Department	Sweden	Tönnersjö	Water and communal infrastructure
62	Real-time regulation	Büro des Oberbürgermeisters, Wiener Kanalisation, Abwasser Management	Austria	Vienna	Water and communal infrastructure
63	Torreele - usage of treated wastewater as drinking water	Intermunicipal Water Company of the Veurne Region (I.W.V.A.)	Belgium	Wulpen	Water and communal infrastructure

	Best practice	Organisation	Country	City	Topic
64	Flood mitigation plan	Institute of Meteorology and Water Management	Poland	Gorzanów	Health and hisaster management
65	Heat wave alert system	City of Paris	France	Paris	Health and hisaster management
66	R.A.C.E.S. campaign for climate consciousness	City of Florence	Italy	Florence	Social attitude forming
67	CO_2 Monitoring Tool for local authorities	European Climate Alliance	International	International	Social attitude forming
68	Climate Star	European Climate Alliance	European	International	Social attitude forming
69	European Green Capital Award	European union	European	International	Social attitude forming
70	Green school project	An Taisce	Ireland	National level	Social attitude forming
71	Step2Save' – Energy-efficiency advice for city tenants	Municipality of Amsterdam, Environmental Protection and Architectural Department	Netherlands	Amsterdam	Deprived groups
72	Targeted energy-efficiency support system	Vzw Recyclant	Belgium	Antwerpen	Deprived groups
73	City of renewable energies	Stadt Prenzlau	Germany	Prenzlau	Deprived groups
74	Local and regional economy development joined to the Amber Trail	Amber Trail Greenways	European	International	Economy
75	Manchester - Co_2llective action on climate change	Manchester City Council	Great Britain	Manchester	Economy
76	Climate Friendly Business' Movement	Climate Friends' Circle	Hungary	Pilis	Economy
77	Hydrogen Systems Laboratory (HYSYLAB)	HYSYLAB	Italy	Turin	Economy
78	A new model for financing emission cuts	The Norwegian Association of Local and Regional Authorities	Norway	National level	Economy

Good practices, which could not be included in the manuscipt of the Handbook due to the physical limits of lenght

	Best practice	Organisation	Country	City	Topic
1	Climate protection		Austria	Graz	Settlement governance
2	Handbook for local decision makers to widen their knowledge about climate	PORSENNA o.p.s.	Czech Republic	Porsenna o.p.s.	Settlement governance
3	Climate Strategy for the Region of Copenhagen	Region Hovedstad – The Copenhagen Region	Denmark	Region of Copenhagen	Settlement governance
4	'Rakvere wants to be the most energy-efficient town in Estonia'	REC Estonia	Estonia	Rakvere	Settlement governance
5	Regional climate change plan	Greater Mulhouse	France	Mulhouse	Settlement governance
6	Automatic energy monitoring and coordination to save money	Leicester City Council	Great Britain	Leicester	Settlement governance

	Best practice	Organisation	Country	City	Topic
7	EXOIKONOMO (integrated strategic planning at local level)	Ministry of Environment, Energy and Climate Change/Department for planning and coordination of NSRF co-financed actions (Energy/Climate Change)	Greece	National level	Settlement governance
8	PRASINI EPIXEIRISI 2010 (green enterprises 2010)	-	Greece	National level	Settlement governance
9	Heat and UV-alarm plan	-	Hungary	Tatabánya	Settlement governance
10	URBAN-NET	URBAN-NET	International	International	Settlement governance
11	Sustainable energy using for communities	SEAI – Sustainable Energy Authority of Ireland	Ireland	Dundalk	Settlement governance
12	Applying an integrated approach to increase energy efficiency	Brocēni Region Council	Latvia	Broceni	Settlement governance
13	Display campaign	Kaunas regional energy agency	Lithuania	Kaunas	Settlement governance
14	Baerum uses market power	Baerum municipality	Norway	Baerum	Settlement governance
15	Energy saving and climate protection in Kristiansand	Kristiansand municipality	Norway	Kristiansand	Settlement governance
16	Green Wave – Co-operation of local stakeholders to reduce energy use	Oslo municipality	Norway	Oslo	Settlement governance
17	Climate and Energy Strategy	Sandnes municipality	Norway	Sandnes	Settlement governance
18	Energy efficiency actions focusing on geothermal energy	Sarpsborg Kommune	Norway	Sarpsborg	Settlement governance
19	A more efficient energy management	Municipal Office in Bielsko-Biała	Poland	Bielsko-Biała	Settlement governance
20	Network of urban entertainers against the climate change in the city of albacete	City Council of Albacete	Spain	Albacete	Settlement governance
21	Agenda 21 Local of the Municipality of Almería	City Council of Almeria	Spain	Almeria	Settlement governance
22	Comprehensive sustainability strategy	City Council of Antequera	Spain	Antequera	Settlement governance
23	EURONET 50-50 50/50 European Network of Education Centres	Barcelona Provincial Council (Diputació de Barcelona) Environment Department	Spain	Barcelona	Settlement governance
24	Municipal comparison circles for waste management, street cleaning & energy efficiency in street lighting - good practice benchmarking	Barcelona Provincial Council (Diputació de Barcelona) Environment Department and Programming Service Department	Spain	Barcelona	Settlement governance
25	Covenant of Mayors support to municipalities in the province of Barcelona	Barcelona Provincial Council (Diputació de Barcelona) Environment Department)	Spain	Barcelona	Settlement governance
26	Diputación provincial de Jaén like Supporting Structure to the Covenant of Mayors: 2020 horizon	County Council Jaén	Spain	Jaén	Settlement governance

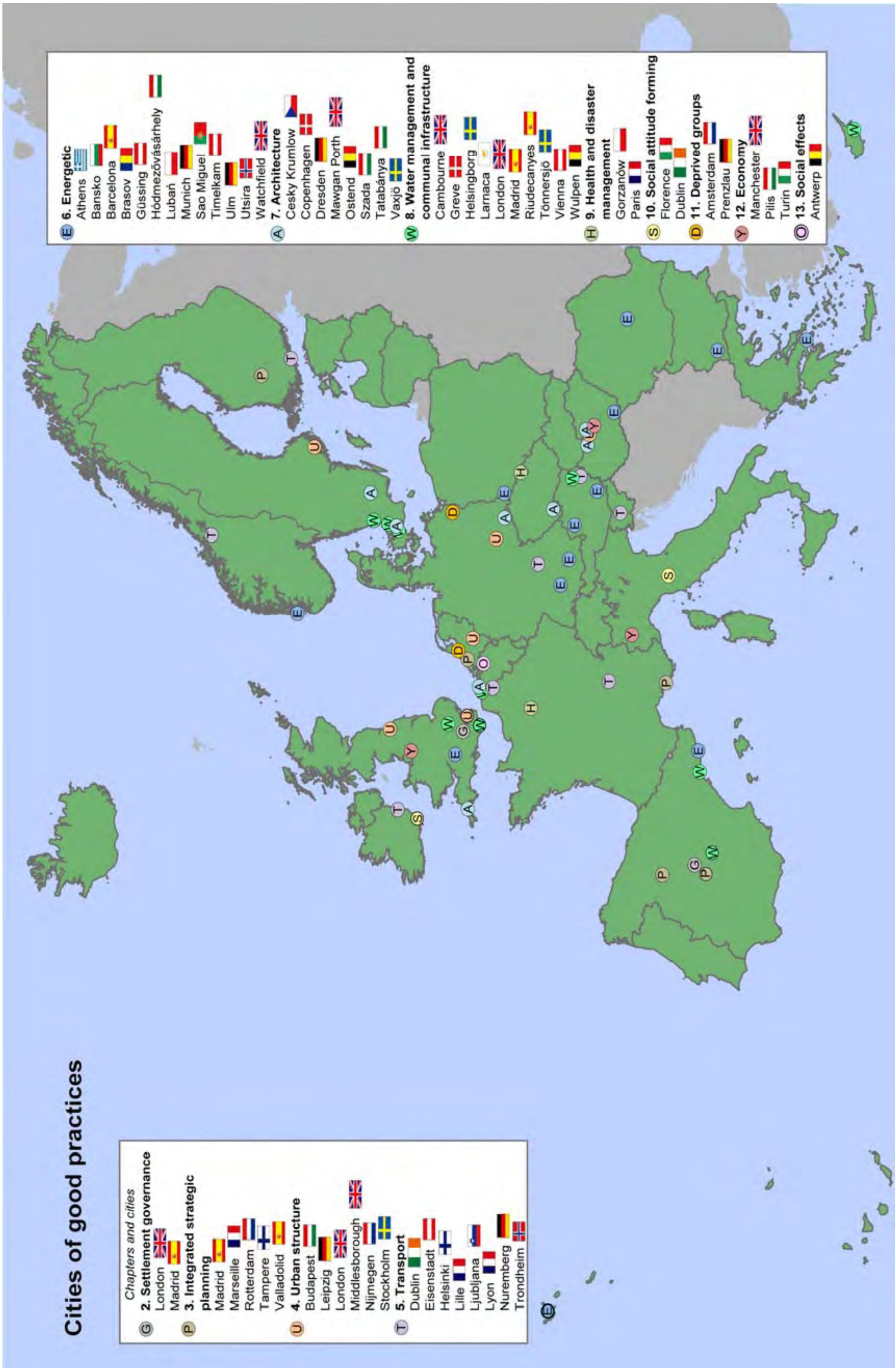
	Best practice	Organisation	Country	City	Topic
27	Creation of a local management energy agency in las palmas de gran canaria	Agencia Local Gestora de la Energía de Las Palmas de Gran Canaria	Spain	Las Palmas de Canaria	Settlement governance
28	Climate change related researches and observations for action plans	Concejalía de Vías Públicas y Entorno Natural. Ayuntamiento de LAs Rozas de MAdrid	Spain	Las Rozas	Settlement governance
29	The sustainable energy action's plan of Viladecans	City Council of Viladecans	Spain	Viladecans (Barcelona)	Settlement governance
30	Comprehensive sustainability program in a particular part of the city	City Of Malmö / Sustainable Urban Development Unit	Sweden	Malmö	Settlement governance
31	Local strategy against climate change	Ayuntamiento De Murcia	Spain	Murcia	Integrated strategic planning
32	Spanish network of cities for climate	Spanish Federation Of Municipalities And Provinces	Spain	National level	Integrated strategic planning
33	Finger Plan 2007- town planning as a tool to reduce CO_2 emission	Danish Ministry Of The Environment, Agency For Spatial And Environmental Planning	Denmark	Copenhagen	Urban structure
34	Fornebu – green-thinking model settlement	Baerum Municipality	Norway	Baerum/ Fornebu	Urban structure
35	Parking places turn to park	Drammen Municipality	Norway	Drammen	Urban structure
36	Broset, the carbon neutral district	Trondheim Municipality	Norway	Trondheim	Urban structure
37	Reforestation of degraded areas that belongs to trading estates susceptible to become uncontrolled dumps.	Ayuntamiento De Fuenlabrada (Madrid)	Spain	Fuenlabrada (Madrid)	Urban structure
38	Green belt Puertollano´s	Public Company Of Environmental Management	Spain	Puertollano	Urban structure
39	Buses driven by natural gas	City of Prostějov	Czech Republic	Prostejov	Transport
40	Center for help to organise transportation	City of Pori	Finland	Pori	Transport
41	TREATISE – eco-leading	Ministry of Economy, Competitiveness and Shipping	Greece, Netherlands, Spain, United Kingdom, Austria, Belgium, Finland, France	National level	Transport
42	MOBINET– sustainable transportation	Ministry of Economy, Competitiveness and Shipping	Greece, Sweden, Portugal, Spain, Italy	Biella-It, Aranda & Miranda (Castilla y Leon)-ES, Eskilstuna-SE, Mieres (Asturias)-ES, Thessaloniki-GR, Evora-PT	Transport
43	Routing plan for workers	National Transport Authority	Ireland	National level	Transport
44	Energy efficient buildings	Energy Agency of the Republic of Macedonia	Macedonia	National level	Energetic
45	Norway's first light train	Bergen Municipality	Norway	Bergen	Transport

	Best practice	Organisation	Country	City	Topic
46	Bicycle shop (fixing, renting, selling)	Fredrikstad municipality	Norway	Fredrikstad	Transport
47	Evolving separated public transport lanes	Kristiansand municipality	Norway	Kristiansand	Transport
48	Reducing CO2 emission	Kristiansand municipality	Norway	Kristiansand	Transport
49	Traffic calming	Kristiansand municipality	Norway	Kristiansand	Transport
50	Supporting electric cars	Oslo municipality	Norway	Oslo	Transport
51	Supporting the climate friendly transport of workers	Porsgrunn municipality	Norway	Porsgrunn	Transport
52	Encouraging bicycle traffic	Sandnes municipality	Norway	Sandnes	Transport
53	Trasport improvement and emission reduction	Sarpsborg Kommune	Norway	Sarpsborg	Transport
54	Electric cars for municipal workers	Tromso municipality	Norway	Tromso	Transport
55	Bici service	Instituto de Planificación y Gestión Ambiental de Alcalá de Henares	Spain	Alcalá de Henares	Transport
56	Provincal strategy for sustainable urban mobility, mobility plans for municipalities under 50.000 inhabitants of the province of Cádiz	County Council of Cádiz	Spain	Cádiz	Transport
57	Chiclana de la Frontera, traffic	City Council Of Chiclana De La Frontera	Spain	Chiclana de la Frontera	Transport
58	Special Plan for Mobility and Infrastructures of the Municipality of León.	León City Council	Spain	Leon	Transport
59	Local Covenant for Sustainable Mobility	Ayuntamiento de Pamplona (City Council of Pamplona)	Spain	Pamplona	Transport
60	Promoting cycling	Gijón City Council	Spain	Gijón	Transport
61	Energy-independent settlement	Municipality of Dobrich	Bulgaria	Dobrich	Energetic
62	Energy efficiency developments in the town	Municipality of Gabrovo	Bulgaria	Gabrovo	Energetic
63	Exploitation of renewable energy	Rakovica Municipality	Croatia	Rakovica	Energetic
64	Promoting renewable energy sources	City of Litoměřice	Czech Republic	Litomerice	Energetic
65	Public heat planning	Danish Energy Agency	Denmark	National level	Energetic
66	Innovative and climate oriented energy manegement of the city council	Kirklees Council Environment Unit	Great Britain	Kirklees	Energetic
67	Bill on renewable energy sources	-	Greece	National level	Energetic
68	Local energy efficiency actions	Jekabpils city municipality	Latvia	Jēkabpils	Energetic
69	Establishing a local organisation for energy affairs	Kaunas regional energy agency	Lithuania	Kaunas	Energetic
70	District heating with 90% renewable energy	Drammen municipality	Norway	Drammen	Energetic
71	'Oil-free Oslo'	Oslo municipality	Norway	Oslo	Energetic
72	70 % energy saving on lighting	Oslo municipality	Norway	Oslo	Energetic
73	District heating with bio fuels	Skien Kommune	Norway	Skien	Energetic
74	Energy and money savings	Czestochowa Municipal Office	Poland	Częstochowa	Energetic

	Best practice	Organisation	Country	City	Topic
75	Actions related to renewable energies and energy efficiency	Mesto Košice	Slovakia	Kassa	Energetic
76	Municipal programme for energy supply and energy using related development plans	Razvojna agencija Sinergija, d.o.o.	Slovenia	Region of Pomurje	Energetic
77	Energy modernisation	Ayuntamiento de Archena	Spain	Archena, Murcia	Energetic
78	Execution of renewable energy and energy efficiency actions in the province of Barcelona	Barcelona Provincial Council (Diputació de Barcelona) Environment Department	Spain	Barcelona	Energetic
79	Public lighting telegestion	Mataró Municipal Council	Spain	Mataró	Energetic
80	Photovoltaic installation and use of solar thermal energy at Pompeu Fabra Library	Mataró Municipal Council	Spain	Mataró	Energetic
81	Tub Verd (Green pipe: District heating)	Mataro Energia Sostenible SA	Spain	Mataró	Energetic
82	Photovoltaic pergolas in Vallveric Park	PUMSA	Spain	Mataró	Energetic
83	Molina de Segura replacing halogen traffic lights with LED technology traffic lights	Ayuntamiento De Molina De Segura	Spain	Molina de Segura	Energetic
84	Changing traffic lights to LED technology	City Council Of Monzón	Spain	Monzón	Energetic
85	Biomass logistic management	City Council Of Puente Genil (Cordoba – España)	Spain	Puente Genil, Cordoba	Energetic
86	Rivas Solar – Enhancing solar power using	Energy Agency / City Council Of Rivas Vaciamadrid	Spain	Rivas Vaciamadrid	Energetic
87	Vigo Pabellón Berbes - solat collectors on the municipial buildings	Instituto De Planificación Y Gestión Ambiental De Alcalá De Henares	Spain	Vigo	Energetic
88	Vigo Pabellón Berbes – solar collectors on a sport arena	Instituto De Planificación Y Gestión Ambiental De Alcalá De Henares	Spain	Vigo	Energetic
89	Photovoltaic panels in schools cándido domingo	City Council Of Zaragoza	Spain	Zaragoza	Energetic
90	Project Retaler – Cross-border co-operation related to renewable energy sources	Ourense Country Council	Spain/Portugal	Province Ourense	Energetic
91	Biogas production and district heating	City of Linköping	Sweden	Linköping	Energetic
92	Rebuilding old buildings to new, energy efficient buildings	Energy Institute Hrvoje Požar	Croatia	Osijek	Architectural
93	Energy efficiency actions to improve life quality	Municipal office of Nový Lískovec	Czech Republic	Brno-Novy Liskovec	Architectural
94	The most climate friendly datacenter on the world	Helsingin Energia	Finland	Helsinki	Architectural
95	Regulating energy efficiency of buildings	-	Greece	National level	Architectural
96	EXOIKONOMISI KAT' OIKON (savings at home)	-	Greece	National level	Architectural
97	PRASINES YPODOMES 2010 (green infrastructure 2010)	-	Greece	National level	Architectural
98	The most climate friendly school in Norway	Drammen municipality	Norway	Drammen	Architectural
99	Climate friendly nursery	Fredrikstad municipality	Norway	Fredrikstad	Architectural

	Best practice	Organisation	Country	City	Topic
100	Supporting modern heating systems	Oslo municipality	Norway	Oslo	Architectural
101	Block of passive houses	Stavanger Kommune	Norway	Stavanger	Architectural
102	Regulation of energy efficiency of urban buildings at local level	OER - Romanian Energy Cities Network	Romania	Brasov	Architectural
103	Rebuilding a XVIII. Century house to an energy efficient office building	Bistra Hiša Martjanci-Smart House Martjanci	Slovenia	Martjanci	Architectural
104	A housing block for young adults constructed according to environmental criteria	Mataró City Council	Spain	Mataró	Architectural
105	Energy audit of council buildings	City Council of Monzón	Spain	Monzón	Architectural
106	Solar collectors on the municipal buildings	City Council of Monzón	Spain	Monzón	Architectural
107	Solar energy utilisation in swimming pools	City Council of Monzón	Spain	Monzón	Architectural
108	Water-heating with solar energy	City Council of Monzón	Spain	Monzón	Architectural
109	Water-heating with solar energy	City Council of Monzón	Spain	Monzón	Architectural
110	Sustainable rehabilitation of Novelda convent house for hostel and environmental interpretation center	Concejalía de Medio ambiente, Ayto Novelda	Spain	Novelda	Architectural
111	Municipal ordinance on the collection and usage of solar thermal energy	City Council of Santander. Councillorship of Environment	Spain	Santander	Architectural
112	Implementation of photovoltaic solar energy installations in public buildings	City Council of Santander. Councillorship of Environment	Spain	Santander	Architectural
113	Implementation of solar thermal energy installations in public buildings	City Council of Santander. Councillorship of Environment	Spain	Santander	Architectural
114	Installation of photovoltaic plaques into the public equipments	City Council of Viladecans	Spain	Viladecans (Barcelona)	Architectural
115	Building affairs, renewable energy, energy efficiency	Gårdstensbostäder	Sweden	Gardsten, Göteborg	Architectural
116	Waste transportation with pipline	Baerum municipality	Norway	Baerum	Water and communal infrastructure
117	Nappy-aid	Fredrikstad municipality	Norway	Fredrikstad	Water and communal infrastructure
118	Shop for free stuffs	Fredrikstad municipality	Norway	Fredrikstad	Water and communal infrastructure
119	Biogas production from sewage and waste	Oslo municipality	Norway	Oslo	Water and communal infrastructure
120	Heating with waste	Porsgrunn municipality	Norway	Porsgrunn	Water and communal infrastructure
121	Establishing a place where old stuffs can be exhanged	Stavanger Kommune	Norway	Stavanger	Water and communal infrastructure
122	Exploitation of rivers	Oslo municipality	Norway	Oslo	Water and communal infrastructure

	Best practice	Organisation	Country	City	Topic
123	Midgard snake – drainage system	Oslo municipality	Norway	Oslo	Water and communal infrastructure
124	Chiclana de la Frontera, waste	City Council Of Chiclana De La Frontera	Spain	Chiclana de la Frontera	Water and communal infrastructure
125	Environmental awareness about recycling	Ayuntamiento De Fuenlabrada (Madrid)	Spain	Fuenlabrada (Madrid)	Water and communal infrastructure
126	EGEMASA – biomass and waste	Egemasa	Spain	Cordoba	Water and communal infrastructure
127	Self compacting semitrailer	City Council Of Puente Genil (Cordoba – España)	Spain	Puente Genil, Cordoba	Water and communal infrastructure
128	Hidric net to recovery the purified wastewater for the use in the green zones irrigation and for the streets cleaning in viladecans	City Council Of Viladecans	Spain	Viladecans (Barcelona)	Water and communal infrastructure
129	Pilot project on residential composting	City Of Chrudim	Czech Republic	Chrudim	Social attitude forming
130	School of sustainable development	Environmental Education Club – Klub Ekologické Výchovy	Czech Republic	Jilemnice	Social attitude forming
131	Danish Internet portal on climate change	Danish Energy Agency	Denmark	National level	Social attitude forming
132	Norway's most environmentally friendly school	Drammen Municipality	Norway	Drammen	Social attitude forming
133	Green days in Sarpsborg	Sarpsborg Kommune	Norway	Sarpsborg	Social attitude forming
134	Green education	Trondheim Municipality	Norway	Trondheim	Social attitude forming
135	Drawing attention to the climate change, and help to understand it	Baia Mare Municipality	Romania	Baia Mare	Social attitude forming
136	Alcalá de Henares education programme	Instituto De Planificación Y Gestión Ambiental De Alcalá De Henares	Spain	Alcalá de Henares	Social attitude forming
137	Efficient schools – Climate-concious education in schools	Environment Area. Gijón City Council.	Spain	Gijón	Social attitude forming
138	'Efficiency Shops – Energy saving, Investing Future'	Environment Area. Gijón City Council.	Spain	Gijón	Social attitude forming
139	Are you green of heart	City Council Of Santander. Councillorship Of Environment	Spain	Santander	Social attitude forming
140	Network of viladecans' environmentally responsible shops	City Council Of Viladecans	Spain	Viladecans (Barcelona)	Social attitude forming


Cities of good practices
Chapters and cities
G 2. Settlement governance
London
Madrid
P 3. Integrated strategic planning
Madrid
Marseille
Rotterdam
Tampere
Valladolid
U 4. Urban structure
Budapest
Leipzig
London
Middlesborough
Nijmegen
Stockholm
T 5. Transport
Dublin
Eisenstadt
Helsinki
Lille
Ljubljana
Lyon
Nuremberg
Trondheim
E 6. Energetic
Athens
Bansko
Barcelona
Brasov
Güssing
Hódmezővásárhely
Lubań
Munich
Sao Miguel
Timelkam
Ulm
Utsira
Watchfield
A 7. Architecture
Cesky Krumlow
Copenhagen
Dresden
Mawgan Porth
Ostend
Szada
Tatabánya
Vaxjö
W 8. Water management and communal infrastructure
Camborne
Greve
Helsingborg
Larnaca
London
Madrid
Riudecanyes
Tönnersjö
Vienna
Wulpen
H 9. Health and disaster management
Gorzanów
Paris
S 10. Social attitude forming
Florence
Dublin
D 11. Deprived groups
Amsterdam
Prenzlau
Y 12. Economy
Manchester
Pilis
Turin
O 13. Social effects
Antwerp

CITED AND OTHER USEFUL REFERENCES

113° Congresso Sat, Moena, Tesi Di Moena, Le Alpi Ed I Cambiamenti Climatici. Moena; 7 Ottobre 2007 www.consiglio.provincia.tn.it/allegati_stampa/20100122155921.pdf

2nd International Scientific "Energy and Climate Change" Conference; Athens; 8-9 October 2009; www.kepa.uoa.gr/PROMITHEAS_Conference_MATERIAL.htm

Abegg, B. (2006): OECD report on adaptation strategies in Alpine ski tourism: a cross country analysis - OECD Workshop - Adaptation to the Impacts of Climate Change in the European Alps, Wengen www.oecd.org/dataoecd/58/4/37776193.pdf

Abdallah, B: Flood risk management; UNESCO-IHE Institute for Water Education www.unesco-ihe.org/content/download/2121/22028/file/Flood%20risk%20management.pdf.

Academy for Spatial Research and Planning: BALTIC CLIMATE Baltic Challenges and Chances for local and regional development generated by Climate Change; Hannover www.seit.ee/failid/608.pdf

Adaptation to Climate Change in Coastal Areas of the ECA Region: A contribution to the *Umbrella Report* on adaptation to climate change in ECA siteresources.worldbank.org/ECAEXT/Resources/258598-1243892418318/Coastal.pdf

ADAM - Adaptation and Mitigation Strategies: Supporting European climate policy, web portal www.adamproject.eu/

Agrawala, S. - Fankhauser, S. (Eds) (2008): Economic Aspects of Adaptation to Climate Change- costs, benefits and policy instruments; OECD Publishing www.oecd.org/document/2/0,3343,en_2649_34361_40691458_1_1_1_1,00.html

AMICA - Adaptation and Mitigation - an Integrated Climate Policy Approach, web portal www.amica-climate.net/

Andalusian Autonomous Government, Ministry of Environment (2010): Guía para la implantación de aparcamientos disuasorios en Andalucía; Programa de Sostenibilidad Urbana CIUDAD 21 www.ciudad21.org/articulos.php

ASTRA project - Developing Policies & Adaptation Strategies to Climate Change in the Baltic Sea Region, web portal www.astra-project.org/

Autonomous Community Castile-La Mancha: Guia práctica para el diseño,implantación y desarrollo de las agendas-21 locales en el marco de la, red de ciudades y pueblos sostenibles de Castilla-La Mancha; agenda.fempclm.com/guia.html

Bader, S. - Bantle, H.(2004): Das Schweizer Klima im Trend, Temperatur- und Niederschlagsentwicklung 1864 – 2000; MeteoSchweiz (Federal Office of Meteorology and Climatology) www.meteoschweiz.admin.ch/web/de/forschung/publikationen/alle_publikationen/Das_Schweizer_Klima_im_Trend.Par.0001.DownloadFile.tmp/veroeffentlichung68.pdf

BaltCICA Project - Climate Change: Impacts, Costs and Adaptation in the Baltic Sea Region, web portal www.baltcica.org/

Barnett, J. - Webber, M. (2009): Accommodating Migration to Promote Adaptation to Climate Change; Secretariat of the Commission on Climate Change and Development; Stockholm www.ccdcommission.org/Filer/documents/Accommodating%20Migration.pdf

Bavarian State Ministry of the Environment and Public Health (2009): Bavarian Climate Programme 2020; München www.stmug.bayern.de/umwelt/klimaschutz/klimaprogramm/doc/klimaprogramm2020_en_05_2009_ba.pdf

Bekele, H (2005): Urbanization and urban sprawl; Stockholm

Bertolino, M. (2008): Cambiamenti climatici e sostenibilitá energetica: la strategia della Regione Piemonte; Coordination Agenda XXI, 29th. May 2008. www.comune.collegno.to.it/aree-tematiche/ambiente/agenda21/seminario_workshop/interventi/Bertolino.pdf

Biodiversität und Klima - Konflikte und Synergien im Massnahmenbereich - Positionspapier des Forum Biodiversität Schweiz der SCNAT; Bern; May 2008; www.biodiversity.ch/d/publications/position_papers/index.php

BLUE-LINK- Bulgarian web-portal on climate change and its impact on the environment, web portal bluelink.net/en/

Bristol Accord Conclusions of Ministerial Informal on Sustainable Communities in Europe, Bristol, 6-7 Dec 2005 webarchive.nationalarchives.gov.uk/+/www.communities.gov.uk/documents/citiesandregions/pdf/143108

Browne, M. - Sweet, M. - Woodburn, A. - Allen, J. (2005): Urban Freight Consolidation Centres, Final Report; University of Westminster; London

Brunner, C.U. - Steinemann, U. – Nipkow, J. (2008): Bauen, wenn das Klima wärmer wird - Empfehlung Nachhaltiges Bauen 2008/2. KBOB Fachgruppe nachhaltiges Bauen c/o BBL Bundesamt für Bauten und Logistik; Bern, www.bbl.admin.ch/kbob/00493/00495/index.html?lang=de&download=NHzLpZeg7t,lnp6I0NTU042l2Z6ln1acy4Zn4Z2qZpnO2Yuq2Z6gpJCDeX97g2ym162epYbg2c_JjKbNoKSn6A--

Bulkeley, H. - Schroeder, H. - Janda, K. - Zhao, J. - Armstrong, A. – Chu, S.Y. - Ghosh S.: (2009): Cities and Climate Change: The role of institutions, governance and urban planning; University of Oxford www.dbsa.org/Vulindlela/Presentations/Session6_Bulkeley.pdf

C.E.U. Climate change and urban design - The Third Annual Congress of the Council for European Urbanism, Oslo; 14-16 Sept 2008. ConferenceE Reader - Background Papers and Excerpts Selected Conference Papers www.cityclimate.no/

Cenacchi, N.: Adaptation to Climate Change in Coastal Areas of the ECA Region siteresources.worldbank.org/ECAEXT/Resources/258598-1243892418318/Coastal.pdf

Center for Environmental Research (CIMA), Ministry of Environment, Government of Cantabria, Spain (2009): Ayuntamientos CeroCO_2 Guía práctica de auditorías de emisiones www.medioambientecantabria.es/guia-aytos-ceroco2/ampliar.php?Id_contenido=24065

The Charter of the Environment, France (2005); Constitutional Law; N. 2005-205; 1st March 2005 www.cidce.org/pdf/Charte_ANGLAIS.pdf

Christoplos, I. - Anderson, S. - Arnold, M. - Galaz, V. - Hedger, M. - Klein, R. J. T. - Le Goulven, K. (2009): The Human Dimension of Climate Adaptation: The Importance of Local and Institutional Issues; Commission on Climate Change and Development; Stockholm www.ccdcommission.org/Filer/report/HUMAN_DIMENSIONS.pdf

Ciscar, J-C. (ed) (2009): Climate change impacts in Europe, final report of the PESETA research project; European Commission Joint Research Centre Institute for Prospective Technological Studies ftp.jrc.es/EURdoc/JRC55391.pdf

City of Ansbach: Klimaschutzprogramm von Ansbach; 2007; www.klimaschutz.ansbach.de/showpage.php?Programm_und_Ma%0Bssnahmen/Klimaschutzprogramm_2007&SiteID=13

City of Brasov: Planul Integrat de Dezvoltare Urbană (PIDU) pentru Polul de Creştere (PC) Braşov www.brasovcity.ro/documente/public/constructii-urbanism/planul-integrat-de-dezvoltare-urbana.pdf

City of Copenhagen, The Technical and Environmental Administration (2009): Copenhagen Climate Plan; Copenhagen www.kk.dk/sitecore/content/Subsites/CityOfCopenhagen/SubsiteFrontpage/InformationAndServices/~/media/558FF07CE64041AE85437BB71D9EDF49.ashx

City of Frankfurt am Main (2007): Klimaschutzbericht Frankfurt 1990-2007; Frankfurt www.frankfurt.de/sixcms/media.php/738/Klimaschutzbericht.pdf

City of Gijon (2004): Environmental Arc of the council of Gijón www.eukn.org/Spain/en/E_library/Urban_Environment/Environmental_Sustainability/Environmental_Sustainability/Environmental_Arc_of_the_council_of_Gij%C3%B3n_Asturias

City of Nanterre, Directorate for Environment (2007): Plan climat territorial de Nanterre www.nanterre.fr/NR/rdonlyres/778951C0-57DA-4BED-9CDC-9D285B0B3986/0/NAN_plan_climat.pdf

City of Paris (2007): Paris Climate Protection Plan; www.paris.fr/portail/viewmultimediadocument?multimediadocument-id=33859

City of Paris, Direction of environment and green areas (2004): Le Bilan Carbone de Paris 2004; www.paris.fr/portail/viewmultimediadocument?multimediadocument-id=61699

City of Stuttgart, Office for Environmental Protection (1997): Climate Protection Programme (KLIKS); www.stadtklima-stuttgart.de/index.php?climate_kliks_intro

City of Tuebingen (2003): Leitlinien für eine nachhaltige Stadtentwicklung www.tuebingen.de/formulardownload/leitlinien_endfassung.pdf

City of Vienna, Executive Office for the Coordination of Climate Protection Measures (2009): Climate Protection Programme of the City of Vienna www.wien.gv.at/english/environment/klip/index.html

Clapp, C.- Leseur, A. - Sartor, O. - Briner, G. – Corfee-Morlot, J. - (2010): Cities and Carbon Market Finance: Taking Stock of Cities, Experience with Clean Development Mechanism (CDM) and Joint Implementation (JI); OECD Environmental Working Paper No. 29; OECD Publishing www.oecd.org/dataoecd/18/43/46501427.pdf

CLAVIER project - Climate Change and Variability: Impact in Central and Eastern Europe, web portal www.clavier-eu.org

Climate Alliance of European Cities, Switzerland (2009): Elektromobilität - Zukunftsperspektive für eine klima- und umweltverträgliche Mobilität in der Stadt?
www.klimabuendnis.ch/cms/download.php?f=ee980d296f943bbbc7e2df5fa71334f0

Climate changes Spatial Planning Programme; Netherlands, web portal
climatechangesspatialplanning.climateresearchnetherlands.nl/

Climate tips of the Federal Office for Environment of Switzerland, web portal
www.bafu.admin.ch/klima/09610/index.html?lang=de

Clini C., - Contaldi M.,- Gaudioso D., - Angeloni M. (2002): Third National Communication Under The Un Framework Convention On Climate Change; National Environmental Protection Agency and Ministry for the Environment and Territory; Italy
unfccc.int/resource/docs/natc/itanc3.pdf

CLISP - Climate Change Adaptation by Spatial Planning in the Alpine Space, web portal
www.clisp.eu

Cluj County (2007): Planul Local de Acțiune pentru Protecția Mediului Județul Cluj
www.apmcluj.ro/fisiere/plam_2007.pdf

Cluj Metropolitan Area: Planul Integrat de Dezvoltare Polul de Crestere Cluj-Napoca - Zona Metropolitană Cluj
www.primariacj.ro/docs/propiecte%20dezbateri/zona%20metropolitana/Planul%20integrat%20de%20dezvoltare%20pentru%20zona%20metropolitana%20Cluj-Napoca.pdf

Colette, A. (2009): Case studies on climate change and world heritage; UNESCO World Heritage Centre; Paris
whc.unesco.org/uploads/activities/documents/activity-473-1.pdf

Commission for Architecture and the Built Environment (CABE): Adapt public space to climate change
www.cabe.org.uk/sustainable-places/adapt-public-space

Commission on Climate Change and Development; Sweden, web portal
www.ccdcommission.org/

Committee of the Regions (2011): Adaptation to Climate Change - Policy instruments for adaptation to climate change in big European cities and metropolitan areas © European Union
www.cor.europa.eu/COR_cms/(S(z3wfmiiou1lhccjnndxkgym4))/ui/ViewDocument.aspx?siteid=default&contentID=5a577d3c-6b00-4450-a610-153e2fd8192b

CONCERTO project - Towards an Integrated Community Energy Policy to Improve the Quality of Citizens' Lives, web portal
www.concertoplus.eu

Conferenza Nazionale Cambiamenti Climatici (2007): E la Sicurezza Ambientale; Conclusioni Conferenza Nazionale Cambiamenti Climatici; Roma; 12 e 13 settembre 2007
www.sardegnaambiente.it/documenti/3_96_20071005132815.pdf

Corfee-Morlot ,J. - Cochran, I. – Hallegatte, S. – Teasdale, P. (2011): Multilevel risk governance and urban adaptation policy, in: Climatic Change "Special Issue: Understanding Climate Change Impacts, Vulnerability and Adaptation at City Scale" Volume 104, Number 1, 169-197

Corfee-Morlot, J. - Kamal-Chaoui, L. - Donovan, M.G. - Cochran, I. - Robert, A. - Teasdale P-J.(2009): Cities, Climate Change and Multilevel Governance, OECD Environmental Working Papers N° 14; OECD publishing
www.oecd.org/dataoecd/30/35/44232263.pdf

Covenant of Mayors, web portal
www.eumayors.eu/

Covenant of Mayors Office: Baseline Emission Inventory & Sustainable Energy Action Plan; Brussels
www.eumayors.eu/mm/staging/library/tml_1/docs/leaflet.pdf

The Covenant of Mayors Committed to urban sustainable energy: Making a commitment to urban sustainable energy
www.pracsis.be/pdf/covenant/brochure_final_lowres.pdf

Cramer, M. (2006): The Development of Transport Policy in Berlin Since the Fall of the Wall, "Towards Carfree Cities V. conference " on July 17-23;. 2005; Budapest
www2.michael-cramer.de/uploads/TowardsCarfreeCitiesEN.doc

Czerny, J.: Bérlakás és építészet *(title in English: Rental housing and architecture)*
www.lakasepitesert.hu/upload/Czerny%20József_prezentáció.ppt

Danish case studies of urban climate change, web portal
www.egu.kl.dk/Klimakort-English/

Danish Energy Agency (2008): Danish strategy for adaptation to a changing climate; Copenhagen
www.kemin.dk/Documents/Klima-%20og%20Energipolitik/klimatilpasningsstrategi_UK_web.pdf

Das Gebäudeprogramm in der Schweiz, web portal
www.dasgebaeudeprogramm.ch/

Davies, M. - Leavy, J. - Mitchell, T. - Tanner, T. (2008): Social Protection and Climate Change Adaption; The Commission on Climate Change and Development; Sweden
www.ccdcommission.org/Filer/pdf/pb_social_protection.pdf

Department for Communities and Local Government, United Kingdom (2007): Climate Change and Urban Green Spaces
www.cchangeproject.org/jsp/uploaded_files/documents/misc/CC%20&%20urban%20green%20spaces.doc

Department for Environment, Food and Rural Affairs, United Kingdom (2008): Adapting to climate change in England, a Framework for Action; London

193.88.185.141/Graphics/Klimatilpasning/Rapporter/12.%20Adapting%20to%20climate%20change%20in%20England%20.pdf

Department for Environment, Food and Rural Affairs, United Kingdom (2009): Adapting to climate change UK Climate Projections; London
www.decc.gov.uk/assets/decc/what%20we%20do/global%20climate%20change%20and%20energy/tackling%20climate%20change/five_point_plan/uk-climate-projections.pdf

Department of Ecology, Energy, Sustainable Development and Spatial Planning; France (2007): 21 collectivité engagées dans la releve du defi climatique
www.developpement-durable.gouv.fr/IMG/pdf/dgec_Recueil_plans_climats.pdf

Department of Ecology, Energy, Sustainable Development and Spatial Planning; France (2009): Rapport annuel au Parlement sur la mise en oeuvre des engagements du Grenelle Environnement; Paris
lesrapports.ladocumentationfrancaise.fr/BRP/094000582/0000.pdf

Department of Energy and Climate Change, United Kingdom (2009): Climate Change Act 2008 Impact Assessment
decc.gov.uk/assets/decc/85_20090310164124_e_@@_climatechangeactia.pdf

Dombois, O.T. - Braun-Fahrländer, Ch. (2004): Gesundheitliche Auswirkungen der Klimaänderung mit Relevanz für die Schweiz; University of Basel
www.google.hu/search?hl=hu&source=hp&q=Gesundheitliche+Auswirkungen+der+Klima%C3%A4nderung+mit+Relevanz+f%C3%BCr+die+Schweiz&meta=&aq=f&aqi=&aql=&oq

Draghetti,T. - Cimatti, E. - Montanarii, L. : Cambiamenti climatici e pianificazione idrica,Regione Emilia- Romagna
www.ermesambiente.it/wcm/acque/sezioni_laterali/menu_02/studi/studiricerche/CambiamentiClimatici_PianificazioneIdrica.pdf

ECOCITIES, web portal
www.energibyer.dk/en-US/Sider/forside.aspx

Eco-city conference 2009, case study - Malmo; Sweden
www.hkip.org.hk/plcc/download/Sweden.pdf

Eco-drive, web portal
www.ecodrive.org/en/home/

The Economic, Social and Environment Council, France (2009): Fiscalité Écologique Et Financement Des Politiques Environnementales; 2009.
lesrapports.ladocumentationfrancaise.fr/BRP/094000588/0000.pdf

EEA-JRC-WHO (2008): Impacts of Europe's changing climate - 2008 indicator-based assessment; Joint EEA-JRC-WHO report; European Environment Agency; Copenhagen
www.eea.europa.eu/publications/eea_report_2008_4/pp1-19_CC2008Executive_Summary.pdf

Energie-Cities – Secretariat (2009): Actions énergie-climat en Suede; Brussels
www.energie-cites.eu/IMG/pdf/dossier_suede_fr.pdf

Energy Cities of Switzerland, web portal
www.energiestadt.ch/d/

Eriuccio, N. (2004): Cambiamenti climatici, mitigazioni ed adattamenti: Una Prioritá per le politiche locali, Presentazione del 2° rapporto sullo stato dell'ambiente e della sostenibilitá della Provincia di Firenze; 11th December 2008
server-nt.provincia.fi.it/ecologicamente/public/misc/2008121915301102.ppt

EUROCITIES Declaration on Climate Change, June 2008
www.eurocities2009.eu/pages.aspx?page=43

EUROHEAT project, web portal
www.euroheat-project.org/dwd/index.php

European Comission – Environment – Water (floods), web portal
ec.europa.eu/environment/water/flood_risk/index.htm

European Commission, Directorate General for Energy and Transport: Energy efficiency in churches; Sweden
www.managenergy.net/download/nr306.pdf

European Commission, Directorate General for Environment (2007): Integrated environmental management, Guidance in relation to the Thematic Strategy on the Urban Environment, Technical Report 2007-2013.

European Environment Agency (2006): The changing faces of Europe's coastal areas, EEA Report No 6/2006, © EEA, Copenhagen
www.eea.europa.eu/publications/eea_report_2006_6

European Environment Agency (2008a): Energy and environment report – Report 6/2008;© EEA, Copenhagen
www.eea.europa.eu/publications/eea_report_2008_6

European Environment Agency, JRC, WHO (2008b): Impacts of Europe's changing climate - 2008 indicator-based assessment Joint EEA-JRC-WHO report, EEA Report No 4/2008; © EEA, Copenhagen
www.eea.europa.eu/publications/eea_report_2008_4

European Environment Agency (2009a): Water resources across Europe — confronting water scarcity and drought, EEA Report No 2/2009; © EEA, Copenhagen
www.eea.europa.eu/publications/water-resources-across-europe

European Environment Agency (2009b): Ensuring quality of life in Europe's cities and towns Tackling the environmental challenges driven by European and global change, EEA Report No 5/2009; © EEA, Copenhagen
www.eea.europa.eu/publications/quality-of-life-in-Europes-cities-and-towns

European Environment Agency (2009c): Regional climate change and adaptation The Alps facing the challenge of changing water resources, EEA Report No 8/2009; © EEA, Copenhagen
www.eea.europa.eu/publications/alps-climate-change-and-adaptation-2009
European Environment Agency (2010a): Towards a resource-efficient transport system - Report 2/2010; © EEA, Copenhagen
www.eea.europa.eu/publications/towards-a-resource-efficient-transport-system
European Environment Agency (2010b): The European environment — state and outlook 2010 (SOER 2010) ; © EEA, Copenhagen, 2010
www.eea.europa.eu/soer/synthesis/synthesis
European Environment Agency (2010c): Understanding climate change — SOER 2010 thematic assessment © EEA, Copenhagen
www.eea.europa.eu/soer/europe/understanding-climate-change
European Environment Agency (2010d): Adapting to climate change — SOER 2010 thematic assessment; © EEA, Copenhagen, 2010
www.eea.europa.eu/soer/europe/adapting-to-climate-change
European Environment Agency (2010e): Water resources: quantity and flows — SOER 2010 thematic assessment; © EEA, Copenhagen
www.eea.europa.eu/soer/europe/water-resources-quantity-and-flows
European Environment Agency (2010f): Marine and coastal environment — SOER 2010 thematic assessment; © EEA, Copenhagen
www.eea.europa.eu/soer/europe/marine-and-coastal-environment
European Environment Agency (2010g): Mapping the impacts of natural hazards and technological accidents in Europe An overview of the last decade, EEA Technical report No 13/2010; © EEA, Copenhagen
www.eea.europa.eu/publications/mapping-the-impacts-of-natural
European Network for Rural Development (2010): Rural Development and Climate Change; EU Rural Review Issue 4
enrd.ec.europa.eu/app_templates/filedownload.cfm?id=101A386E-C8C0-9369-8912-C42045DDE42D
EUROSION - A European initiative for sustainable coastal erosion management, web portal
www.eurosion.org
EVE – IHOBE S. A.- ORUBIDE – VISESA S. A. (2006): Guía de Edificación Sostenible para la Vivienda en la Comunidad Autónoma del País Vasco
www.ingurumena.ejgv.euskadi.net/r49-6172/es/contenidos/manual/guia_edificacion/es_pub/adjuntos/guia_edificacion.pdf
Exceter City Council (2008): Climate Change Strategy
www.exeter.gov.uk/index.aspx?articleid=10173
Expert Group on the Urban Environment, EU: Targeted Summary of the European Sustainable Cities Report for Local Authorities
ec.europa.eu/environment/urban/pdf/locsm-en.pdf
Federal Government of Germany (2008): German Strategy for Adaptation to Climate Change;
www.bmu.de/files/english/pdf/application/pdf/das_gesamt_en_bf.pdf
Federal Ministry of Agriculture, Forestry, Environment and Water Management, Austria (2007): Anpassung der Klimastrategie Österreichs zur Erreichung des Kyoto-Ziels 2008-2013; Wien
umwelt.lebensministerium.at/article/articleview/70701/1/7337/)
Feenstra, J.F. - Burton, I. - Smith, J.B. - Tol, R.S.J (eds) (1998): Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies; United Nations Environment Programme - Institute for Environmental Studies; Netherlands
dare.ubvu.vu.nl/bitstream/1871/10440/1/f1.pdf
Ferrara, V. - Lanza, A. (2003): La risposta a cambiamento climatico in Italia, Valutazioni socio-economiche delle strategie di adattamento, Misure di mitigazione forestale; ENEA (National Agency for New Technologies, Energy and the Environment)
www.enea.it/produzione_scientifica/volumi/V2003_CambiamentoClimatico.html
Final statement by the ministers in charge of urban development, Marseille, 25 Nov 2008
www.eib.org/attachments/jessica_marseille_statement_en.pdf
Flemish Government, The Environment, Nature and Energy Department (2006): The Flemish Climate Policy Plan 2006 - 2012
www.lne.be/themas/klimaatverandering/vlaams-klimaatbeleidsplan-2006-2012/flemish-climate-policy-plan-2006-2012
Forum Biodiversität Schweiz (2007): Hotspot: Biodiversität und Klimawandel, Biodiversität: Forschung und Praxis im Dialog
www.bafu.admin.ch/klima/00509/00514/index.html?
Francke, P. (2008): Municipal Responses to Climate Change Emergencies - The Swedish and Danish cases; Nordregio - Nordic Center for Spatial Development; Stockholm
www.nordregio.se/munires/Kristianstad_Hedensted_Greve.pdf
FRMRC - Flood Risk Management Research Consortium, web portal
www.floodrisk.org.uk

Gayer, J. - Ligetvári, F. (2007): Települési vízgazdálkodás, csapadékvíz-elhelyezés *(title in English: Urban water management and rainwater disposal)*; Hungarian Ministry for Environment and Water; Budapest
www.kvvm.hu/data/kiadvanyok/kvvm_kiadvany_4.pdf

Genesio L., - Grasso V., - Vaccari F.,(IBIMET CNR): Segnali Climatici, Il Cambiamento Climatico Dagli Scenari Globali Alle Strategie Locali; Firenze; 15-16 Luglio 2004
www.rete.toscana.it/sett/pta/stato_ambiente/clima/segnali_climatici.pdf

Geological Survey of Finland (GTK), (2003): Sea Level Change Affecting the Spatial Development of the Baltic Sea Region; Seareg 2nd progress report
www.gsf.fi/projects/seareg/SEAREG2ndreport.pdf

Georgi, B. (2005): "Least Cost Transportation Planning - Enabling Municipalities to Identify the Real Costs of Transport", Towards Carfree Cities V Conference – Budapest; 18-21 July 2005; In:"The Secret of a Successful City" (conference summary), Edited by Judit Madarassy, The selection of V International Conference on Towards CarFree Cities V., The Clean Air Action Group (CAAG) – Hungarian Transport Club, Budapest, 2006
www.levego.hu/kiadvanyok/a_sikeres_varos_titka

Gill, S.E. - Handley, J.F - Ennos, A. R. - Pauleit, S. (2007): Adapting Cities for Climate Change: The Role of the Green Infrastructure; In: Built Environment 33., 1., pp. 115.-133.
www.fs.fed.us/ccrc/topics/urban-forests/docs/Gill_Adapting_Cities.pdf

Godwin, P. - Hass-Klaus, C. - Cairns S. (1998): Evidence on the Effects of Road Capacity Reduction on Traffic Levels (report summary); London
www.worldcarfree.net/resources/freesources/Evide.htm

Government of Estonia (1998)*:* Estonian second National Report under the United Nation`s Framework Convention on Climate Change;
unfccc.int/resource/docs/natc/estnc2.pdf

Government's Ministerial Working Group on Climate and Energy, Finland (2008): PolicyLong-term Climate and Energy Strategy; Government Report to Parliament
www.tem.fi/files/20587/Climate_Change_and_Energy_Strategy_2008_summary.pdf

GRABS-project - Green and blue space, adaptation for urban areas and eco towns, web portal
www.grabs-eu.org/

Graham, J. - Querrien, A. - de Santiago Rodríguez, E. (2009): Climate change in the European urban context, City Futures in a Globalising World An international conference on globalism and urban change 4 to 6 June 2009; Madrid
www.cityfutures2009.com/PDF/16_Graham_June.pdf

Greater London Authority (2005a): Adapting to climate change: a checklist for development Guidance on designing developments in a changing climate; London
www.climatesoutheast.org.uk/images/uploads/Adaptation_Checklist_for_Development_Nov_2005.pdf

Greater London Authority (2005b): Climate change and London's transport systems; London
www.london.gov.uk/lccp/publications/docs/climatetransportsept05.pdf

Greater London Authority (2006): Adapting to climate change: Lesson for London; Greater London Authority; London
www.london.gov.uk/lccp/publications/docs/adapting-climate-change-london.pdf

Greater London Authority (2007): Action today to protect tomorrow: the Mayor's Climate Change Action Plan; London
static.london.gov.uk/mayor/environment/climate-change/docs/ccap_summaryreport.rtf

Greater London Authority (2010): The draft climate change adaptation strategy for London, public consultation draft
legacy.london.gov.uk/mayor/priorities/docs/Climate_change_adaptation_080210.pdf

Hallegatte, S. - Corfee-Morlot, J. (2011): Understanding climate change impacts, vulnerability and adaptation at city scale: an introduction in: Climatic Change "Special Issue: Understanding Climate Change Impacts, Vulnerability and Adaptation at City Scale" Volume 104, Number 1, 1-12

Hallegatte, S.- Henriet, F. - Corfee-Morlot, J. (2011): The economics of climate change impacts and policy benefits at city scale: a conceptual framework in: Climatic Change "Special Issue: Understanding Climate Change Impacts, Vulnerability and Adaptation at City Scale" Volume 104, Number 1, 51-87

Hanson, C.E. et al.: MICE project - Modelling the Impact of Climate Extremes
prudence.dmi.dk/public/publications/PSICC/Hanson-et-al.pdf

Hernández, R.C. - Hernández A. (2004): Responsabilidad y práctica municipal ante el cambio climático
www.ciccp.es/biblio_digital/Urbanismo_I/congreso/pdf/040402.pdf

Hopkins, R. (2008): The Transition Handbook: from oil dependency to local resilience, Green Books Ltd.
transitionculture.org/shop/the-transition-handbook/

Hudek, V.(ed) (2007): Ecological footprint, climate change and cities; REC Slovakia; Bratislava
www.udrzatelnemesta.sk/uploads/EcologicalFootprint.pdf

Hungarian Environmental Economics Centre (2004): Magyarország jelentős üvegházgáz kibocsátó ágazatainak közgazdasági prognózisa 2012-ig *(title in English: Economic prognosis of sectors produce greenhouse gas emission for 2012)*; Hungarian Ministry for Environment and Water
makk.zpok.hu/files/REKK%20MAKK%20UHG%20prognozis.pdf

Hungarian Federation for Structural Concrete, web portal
www.terko.com

Huschebeck, M. - Allen, J. (2005): Best Urban Freight Solutions, Policy and research recommendations I., Urban consolidation centres, Last miles solution
www.bestufs.net/download/BESTUFS_II/key_issuesII/BESTUFS_Recommendations.pdf
Institute for Energy and Environment Francophony (2009): Efficacité énergétique en milieu urbain - Études de cas; Quebec
www.energie-cites.eu/IMG/pdf/EE_en_milieu_urbain_etudes_de_cas_Prisme_IEPF_2009.pdf
Institute for Snow and Avalanche Research (SLF) (2006): Bilanzierung und Reduktion der CO_2-Emissionen in der Landschaft Davos. Eine Machbarkeitsstudie zum Klimaschutz. Schlussbericht zum KTI-Projekt Nr. 7984.1.SLF;Davos
www.bafu.admin.ch/klima/09610/index.html?lang=de&download=NHzLpZeg7t,lnp6I0NTU042l2Z6ln1acy4Zn4Z2qZpnO2Yuq2Z6gpJCEeX17gmym162epYbg2c_JjKbNoKSn6A--
Institute of Atmospheric Sciences and Climate (ISAC) of the Italian National Research Council (CNR) (2009): Clima, cambiamenti climatici globali e loro impatto sul territorio nazionale; ISAC-CNR; Bologna
www.iaeg.it/documenti/pubblicazioni/ISAC-Clima.pdf
Interministerial Committee for Sustainable Development, France (2010): National Sustainable Development Strategy of France 2010-2013 (SNDD)
www.developpement-durable.gouv.fr/IMG/pdf/NSDS4p.pdf
International Association of Public Transport (UITP) (2003): "Mobility in Cities Database"
www.uitp.org/publications/Mobility-in-Cities-Database.cfm
International Association of Public Transport (UITP) and European Union Committee (2006): "The role of public transport to reduce greenhouse gas emissions and improve energy efficiency" - position paper
www.uitp.org/eupolicy/positions/2006/03/Climate_Change_EN.pdf
IPCC-Intergovernmental Panel on Climate Change, web portal
www.ipcc.ch
Jacob, D. - Horányi, A. - Li, L. - Gobiet, A. - Pfeifer, S. - Bálint G. - Pálvölgyi, T. - Prettenthaler, F. (2008): Climate Change and Variability: Impact on Central and Eastern Europe; In: The EGGS (EGS Newsletter) Issue 25 October, pp. 22.-26.
*Jank, R.(*ed)(2000): Advanced local energy planning - guidebook; International Energy Agency
www.ecbcs.org/docs/annex_33_alep_II_web.pdf
Johnson, F.X. - Lambe, F.(2009): Energy Access, Climate and Development; The Commission on Climate Change and Development; Stockholm
www.ccdcommission.org/Filer/commissioners/Energy.pdf
Kamal-Chaoui, L. – Robert, A. (eds.) (2009): 'Competitive Cities and Climate Change', OECD Regional Development Working Papers N° 2, 2009, OECD publishing, © OECD
www.oecd.org/dataoecd/30/36/44232251.pdf
Kasser, T. (2009): Shifting Values in Response to Climate Change; In: State of the World 2009: Into a warming World; Worldwatch Institute, W. W. Norton & Co; New York pp. 122-125.
www.worldwatch.org/files/pdf/SOW09_CC_values.pdf
Kentala- Lehtonen, J. (2008): Municipal Response to Climate Change Emergencies and Lithuania;Nordregio - Nordic Center for Spatial Development; Stockholm
www.nordregio.se/munires/Casestudy_%20Panevezys_%20and_%20Lithuania.pdf
Kerr, A. - McLeod, A. (2001): Potential adaptation strategies for climate change in Scotland; Scottish Executive Central Research Unit
www.scotland.gov.uk/Resource/Doc/156668/0042100.pdf
Keskitalo, E. - Carina H. (eds.) (2010): Developing Adaptation Policy and Practice in Europe: Multi-level Governance of Climate Change Springer Science+Business Media B.V.
www.springer.com/environment/global+change+-+climate+change/book/978-90-481-9324-0
Kirby, A. (2008) Kick the Habit: A UN Guide to Climate Neutrality, UNEMG, UNEP/GRID Arendal
www.grida.no/publications/vg/kick/ebook.aspx
Klimabündnis-Climate Alliance Switzerland, web portal
www.klimabuendnis.ch
Klimatkommunerna - The Climate Municipalities of Sweden, web portal
www.klimatkommunerna.se
Klimazug-Nord - Regional strategies concerning climate changes in the metropolitan area of Hamburg, web portal
klimzug-nord.de/
Krusche, P. - Althaus, D. - Gabriel, I. (1982): Ökologisches Bauen; Wiesbaden-Berlin; Bauverlag
Kurkela, L. - Hellenberg, T. - Visuri, P. (2008): Countering the Impacts of Climate Change; Helsinki
www.nordregio.se/munires/Helsinki_%20and_%20Kittil%E4.pdf
Láng, I. (ed) (2007): A globális klímaváltozás: hazai hatások és válaszok, A VAHAVA jelentés, *(title in English: Global climate change: domestic impacts and responses, The VAHAVA report)*; Szaktudás Kiadó Ház; Budapest
Lazio Region (2008): Programmi regionali sulle rinnovabili, La Programmazione regionale 2006 - 2008, Energie rinnovabili e risparmio energetico
www.regione.lazio.it/web2/contents/energie_rinnovabili/argomento.php?vms=4
Le Goulven, K. (2008): Financing Mechanisms for Adaption, Sweden; Commission on Climate Change and Development
www.ccdcommission.org/Filer/documents/financing_adaptation_080603.pdf

Leicester City Council (2003): Climate Change Strategy
www.environmentcity.org.uk/article.asp?ParentID=0&ArticleID=4
Leipzig Charter on Sustainable European Cities, Agreed on the occasion of the Informal Ministerial Meeting on Urban Development and Territorial Cohesion in Leipzig on 24 / 25 May 2007
www.rfsustainablecities.eu/IMG/pdf/LeipzigCharte_EN_cle1d4c19.pdf
Leipzig Charter on Sustainable European Cities, Leipzig , 24 May 2007
www.eu2007.de/en/News/download_docs/Mai/0524-AN/075DokumentLeipzigCharta.pdf
Local Government Climate change leadership summit, conference; June 2009;
www.kl.dk/localclimatesummit/Artikler/57115/2009/06/fdsfdsfdfdsf/
Local Governments for Sustainability (ICLEI) - Robrecht,H. - Morchain, D. (2010): Background document workshop 4 - Adaptation in cities & quality of life ICLEI conference: Adaptation to the changing climate: time to intensify efforts Brussels, 23-24 November 2010
www.lne.be/en/2010-eu-presidency/events/climate-adaptation-conference/agenda/conference-day-2/background-ws-4-adaptation-in-cities-quality-of-life
A local climate impacts profile: how to do an LCLIP, web portal
www.ukcip.org.uk/index.php?option=com_content&task=view&id=278
London Climate Change Partnership (2002): London's warming - The Impacts of Climate Change on London; Greater London Authority; City Hall
www.london.gov.uk/lccp/publications/impacts.jsp
Lotze-Campen, H. - Claussen, L. - Dosch, A. - Noleppa, S. - Rock, J. - Schuler, J. - Uckert, G. (2009): Klimawandel und Kulturlandschaft Berlin; Potsdam Institute for Climate Impact Research; Potsdam
www.pik-potsdam.de/research/publications/pikreports/.files/pr113
MALTESE project - Management and Assessment of Light Trains for Energy Saving and Efficiency, web portal
www.ivv-aachen.de/maltese/index.htm
Manchester City Council (2009): Manchester. A certain future
www.manchesterclimate.com/
Manifesto per il clima - un new deal per l'adattamento sostenibile; 2007. Conclusioni Conferenza Nazionale Cambiamenti Climatici Roma; 12 e 13 settembre 2007
www.wwf.it/UserFiles/File/News%20Dossier%20Appti/DOSSIER/dossier%20clima/13settManifesto%20Clima.pdf
MARCLIM project - Marine Biodiversity and Climate Change, web portal
www.mba.ac.uk/marclim/
Mathey, J. - Rößler, S. - Wende, W. (2010): Role of Urban Green Spaces for Cities under Climate Change Aspects of Planning and Implementation; UNECE Prague 4th May 2010
www.mmr.cz/getdoc/db2d71e7-e8d6-414b-9682-bb4e8ac65c27/Mathey_Prag_UNECE_final_04052010
Ministry of Ecology and Development, France (2004): Plan climat, Face au changement climatique Agissons ensemble
www.bourgogne.gouv.fr/assets/bourgogne/files/dvlpt_durable/plan_climat.pdf
Ministry of Ecology and Development, France (2004): Plan Climat; Paris
www.developpement-durable.gouv.fr/IMG/ecologie/pdf/PLAN-CLIMAT-2004-2.pdf
Ministry of Ecology and Sustainable Development, France (2006): Plan Climat 2004-12 actualisation 2006; Paris
www.developpement-durable.gouv.fr/IMG/pdf/plan-climat-2006.pdf
Ministry of Ecology and Sustainable Development, France (2007): Plans climat territoriaux: des territoires en action 2007
www.developpement-durable.gouv.fr/IMG/pdf/dgec_Recueil_plans_climats.pdf
Ministry of Environment and Rural and Marine Affairs, Spain (2006): The Spanish National Climate Change Adaptation Plan (PNACC)
www.mma.es/secciones/cambio_climatico/documentacion_cc/divulgacion/pdf/pnacc_ing.pdf
Ministry of Environment and Water of Bulgaria (2005): Second national action plan on climate change 2005- 2008
www2.moew.government.bg/recent_doc/international/climate/NAPCC_Final_English.doc
Ministry of Environmental Protection, Physical Planning and Construction, Croatia (2007): Capacity Building for Implementation of the United Nations Framework Convention on Climate Change and the Kyoto Protocol in the Republic of Croatia
klima.mzopu.hr/default.aspx?id=48
Ministry of Housing, Spatial Planning and the Environment, The Netherlands (2008): New Energy for Climate Policy - the 'clean and efficient' programme
www.eceee.org/MembersForum/NL_Agency/Reports_0/
Ministry of the Environment of Spain-The Spanish Net of Cities for Climate. The Spanish Federation of Municipalities and Provinces (FEMP) - Ayuntamiento de Vitoria-Gasteiz (2006): Trabajando en red por el clima y la sostenibilidad
www.redciudadesclima.es/index.php/publicaciones/verpublicacion/id_publicacion/132
Ministry of the Environment of Spain-The Spanish Net of Cities for Climate. The Spanish Federation of Municipalities and Provinces (FEMP) (2009): Estrategia Local de Cambio Climático
www.redciudadesclima.es/uploads/documentacion/f1f6dcd63d369dfe21f0fdaa31835387.pdf
Ministry of the Environment of the Czech Republic - Czech Hydrometeorological Institute (2006): Fourth National Communication of the Czech Republic on the UN Framework Convention on Climate Change and Demonstrable Progress Report on Implementation of the Kyoto Protocol; Ministry of the Environment
unfccc.int/resource/docs/natc/czenc4.pdf

Ministry of the Environment of the Czech Republic (2004): National Program to abate the climate change impacts in the Czech Republic
www.mzp.cz/C125750E003B698B/en/national_programme/$FILE/OZK-National_programme-20040303.pdf
Ministry of the Environment of the Slovak Republic Slovak Hydrometeorological Institute (2005): The Fourth National Communication of the Slovak Republic on Climate Change;
unfccc.int/resource/docs/natc/slknc4.pdf
Minx, J.- Creutzig, F.- Medinger, V- Ziegler, T. - Owe, A. - Baiocchi, G. (2011): Developing a pragmatic approach to assess urban metabolism in Europe - A report to the European Environment Agency, Climatecon Working Paper Series, No. 1-2011.
ideas.climatecon.tu-berlin.de/documents/wpaper/CLIMATECON-2011-01.pdf
MIR - Green Investments in Sweden, web portal
klimp.naturvardsverket.se/mir/index.jsp?lang=en
Müller, H. - Weber, F. (2008): 2030: Der Schweizer Tourismus im Klimawandel - Studie des Forschungsinstituts für Freizeit und Tourismus (FIF) der Universität Bern im Auftrag von Schweiz Tourismus; Bern
www.stnet.ch/de.cfm/ueber_uns/facts/offer-Ueber_uns-Facts-320348.html
Murcia City Council (2008): Estrategia Local Frente al Cambio Climático del Municipio de Murcia (2008-2012)
www.murcia.es/DocumentosPDF/CAMBIO_CLIMATICO.pdf
*Nagy, I. (*2008): Városökológia *(title in English: Urban ecology)*; Dialog Campus; Budapest-Pécs
Nanni, T. - Prodi, F. (2008): Cambiamenti Climatici: La Situazione In Italia; In: Energia, n. 1./2008, pp. 66-71.
National Agency for New Technologies, Energy and the Environment (ENEA): Progetto Speciale Clima Globale: Convenzione ENEA - Regione Abruzzo per lo studio di fattibilitá per la valutazione della vulnerabilitá e degli impatti delle variazioni climatiche sulla Regione Abruzzo ed ipotesi di adattamento
www.regione.abruzzo.it/xambiente/docs/svilSostInizProg/Rapporto_finale_ENEA.pdf
National Climate Commission, Belgium (2008): Plan National Climat de la Belgique 2009 - 2012; Commission Nationale Climat
www.climat.be/IMG/pdf/PNC_2009-2012.pdf
Nerlander, L.(2009): Climate Change and Health; The Commission on Climate Change and Development; Stockholm
www.ccdcommission.org/Filer/commissioners/Health.pdf
Netherlands Environment Assessment Agency (2005) : The effects of climate change in the Netherlands
www.rivm.nl/bibliotheek/rapporten/773001037.pdf
Neuman, M. (2005): The Compact City Fallacy; In: Journal of Planning Education and Research September 2005 25; London. pp. 11-26.
Nilson, A. - Kiviste, A. - Korjus, H. - Mihkelson, S. - Etverk, I. - Oja, T. (1999): Impact of recent and future climate change on Estonian forestry and adaptation tools; In: Climate Research 12. Vol. /1999., pp. 205.- 214.
www.int-res.com/articles/cr/12/c012p205.pdf
Observatoire national sur les effets du Réchauffement Climatique: Stratégie nationale d'adaptation au changement climatique; 2007.
www.developpement-durable.gouv.fr/IMG/ecologie/pdf/Strategie_Nationale_2.17_Mo-2.pdf
OECD: (2008): Competitive Cities and Climate Change - OECD Conference proceedings Milan, Italy 9-10 October 2008
www.oecd.org/document/23/0,3343,en_21571361_41059646_42450007_1_1_1_1,00.html
OECD (2009a): Green Cities New Approaches to Confronting Climate Change; Workshop Proceedings
Las Palmas De Gran Canaria; Spain 11 June 2009
www.oecd.org/dataoecd/46/33/45377963.pdf
*OECD (*2009b): The Economics of Climate Change Mitigation- policies and options for global action beyond 2012.
www.oecd.org/document/56/0,3746,en_2649_33713_43705336_1_1_1_1,00.html
OECD (2010): Cities and Climate Change; OECD Publishing
dx.doi.org/10.1787/9789264091375-en
OECD-IEA (2009) World Energy Outlook 2009
Öko-Institut - Energieagentur Regio Freiburg (2007): Klimaschutzstrategie der Stadt Freiburg; Freiburg
www.freiburg.de/servlet/PB/show/1173335/Umwelt_Klimaschutz-Strategie.pdf
OSE-Observatory on Sustainability in Spain, web portal
www.sostenibilidad-es.org/Observatorio+Sostenibilidad
Páldy, A. - Bobvos, J. - Vámos, A. - Kovats, R.S. – Hajat, S. (2005): The effect of temperature and heat waves on daily mortality in Budapest, Hungary, 1970-2000 In: ‘Extreme weather events and Public Health Responses’ eds.: W Kirch and B Menne. Publisher: Springer-Verlag; Berlin Heidelberg pp. 99-108
Páldy, A. - Bobvos, J. (2008): The health impacts of heatwaves in Hungary; 2007, In: Klíma21 (52) pp. 3-15.
Páldy, A. - Erdei, E. - Bobvos, J. - Ferenczi, E. - Nádor, G. - Szabó, J. (2003): The health impacts of climate change In: Agro-21, 32; pp. 62-76.
Pálvölgyi, T. (2008a): Az éghajlatváltozás hatásai az épített környezetre és az infrastruktúrára *(title in English: The impacts of climate change in the built environment and infrastructure)*. In: A fenntartható fejlődés és a megújuló természeti erőforrások környezetvédelmi összefüggései a Kárpát-medencében. *(title in English: The environmental contexts of sustainable development and renewable natural resources in the Carpathian Basin.)* eds. Fodor, I. and Suvák, A., Centre for Regional Studies of Hungarian Academy of Sciences; Pécs

Pálvölgyi, T. (2008b): Gazdaság, társadalom, infrastruktúra. *(title in English: Economy, society, infrastructure)* In: Klímaváltozásról mindenkinek *(title in English: About the climate change for everybody)* eds.: Harnos, Zs.; Gaál, M.; Hufnagel, L.; Corvinus University of Budapest; Budapest

Pethő, L. (2008): "A hőmérséklet eloszlás alakulása az aszfalt burkolatú útpályaszerkezetekben és ennek hatása a pályaszerkezeti rétegek fáradási méretezésére, technológiai tervezésére" *(title in English: Temperature distribution in the asphalt-paved runways and its impacts on the layers fatigue dimensioning and technological design)* Ph.D dissertation, BUTE Department of Highway and Railway Engineering.; Budapest
www.omikk.bme.hu/collections/phd/Epitomernoki_Kar/2008/Petho_Laszlo/tezis_hun.pdf

Philibert, C. (2010): Interactions of Policies for Renewable Energy and Climate- Working Paper; International Energy Agency; Paris
www.iea.org/papers/2011/interactions_policies.pdf

Piana, V. (2009): Climate Change and Adaptation Strategies, The Italian Case, Ankara; 19. November 2009.
economicswebinstitute.org/presentations/Climate%20Change%20and%20Adaptation%20Strategies%20%96%20The%20Italian%20Case.ppt

PIK - Potsdam Institute for Climate Impact Research, web portal
www.pik-potsdam.de/

Policy Research Corporation (in association with MRAG): The economics of climate change adaptation in EU coastal areas;
www.sesame-ip.eu/doc/report_en.pdf

Portsmouth Sustainability Action Group City Of Portsmouth (2009): Climate Change Strategy;
www.portsmouth.gov.uk/media/STP_climatechangestrategy.pdf

Premios Ciudad Sostenible- Sustainable City Awards of Spain, web portal
www.premiociudadsostenible.com/edicion07.html

Prime Minister's Office, Sweden (2009): A sustainable energy and climate policy for the environment, competitiveness and long-term stability
www.regeringen.se/content/1/c6/12/00/88/d353dca5.pdf

Project for Public Spaces (2000) How to Turn a Place Around? A Handbook for Creating Successful Public Spaces; New York

Prutsch, A. - Grothmann, T - Schauser, I - Otto, S. - McCallum, S. (2010): Guiding principles for adaptation to climate change in Europe, ETC/ACC Technical Paper 2010/6
climate-l.iisd.org/news/eea-publishes-guiding-principles-for-adaptation/

Regional Agency for Environment protection of Liguria (2007): Cambiamenti climatici: l'impegno di Arpal e le sua attività Savona, Fortezza del Priamar, Genova; April 2000
www.provincia.savona.it/temi/ambiente04/educambiente07/doc/soracco.pdf

Resilient city, web portal
www.resilientcity.org/

Rhodia Energy Services (2008): Méthode pour les Projets Domestiques: Destruction de N_2O émis par la production d'acide adipique
www.developpement-durable.gouv.fr/IMG/pdf/9-Methode_N2O_AA_.pdf

*Ribeiro, M.M - Losenno, C. - Dworak, T. - Massey, E. - Swart, R. - Benzie, M. – Laaser, C.(*2009): Final report - Design of guidelines for the elaboration of Regional Climate Change Adaptations Strategies; Ecologic Institute; Berlin
ec.europa.eu/clima/documentation/adaptation/docs/RAS%20Final%20Report.pdf

Ricz J – Tomay K. – Salamin G. (2009): Improvement of town planning: Analysis and recommendations based on international experiences. Scientific Report. VÁTI Spatial Planning and Evaluation Directorate; Budapest.

Romanian Ministry of Environment and Water Management: National Action Plan on Climate Change of Romania (2005-2007)
ns1.mmediu.ro/vechi/departament_mediu/schimbari_climatice/1_Documentatie/PNASC_en.pdf

Romanian Ministry of Environment and Water Management: National Strategy on Climate Change of Romania (2005-2007)
unfccc.int/resource/docs/nap/romadd1.pdf

Rowell, A. (2010): Communities, Councils and a Low-Carbon Future: what we can do if governments won't, Green Books Ltd.
transitionculture.org/shop/communities-councils-low-carbon-future/

Royal Haskoning, Cambridgeshire County Council (2010) Lamb Drove SUDS Showcase Project, Cambourne Interim Monitoring Report January 2010.
www.cambridgeshire.gov.uk/NR/rdonlyres/59774E4C-CE12-4C2A-9A22-AE2781F3D55F/0/LambDroveSUDSMonitoringInterimReportv102Main.pdf

Russu, R. - Bucciantini, V. - Nuvoli, S. - Niccolai, M. - Musetti, N. - Alderighi, S. - Marchi S. (2007): I Servizi a supporto dell'agricoltura toscana in relazione ai cambiamenti; A.R.S.I.A. - Agenzia Regionale Sviluppo e Innovazione nel Settore Agricolo – Forestale; Firenze
innovazione.arsia.toscana.it/UserFiles/File/BORSE/Relazione%20cambiamenti%20climatici%20Russu.pdf

Russu, R. (2007): Climatici, Agricoltura toscana e mutamenti climatici: scenari, contesti, locali, strategie 29/06/2007
archivio.arsia.toscana.it/UserFiles/File/convegni/Clima20060629/ARSIA%20-%20Presentazione%20Cambiamenti.pdf

Salamin G. - Sütő A. – Ricz J. - Hoffmann Cs. – Gere L. (2009): Uncoordinated territorial expansion of cities – Challenges and potential planning responses in Hungary. Scientific Report. VÁTI Spatial Planning and Evaluation Directorate; Budapest.
www.eukn.org/Dossiers/Demographic_Change/Interviews/The_problem_of_uncoordinated_urban_expansion

Satterthwaite D., Huq S., Pelling M., Reid H., Romero Lankao P.(2007) : Adapting to Climate Change in Urban Areas, The possibilities and constraints in low- and middle-income nations
pubs.iied.org/pdfs/10549IIED.pdf

Schauser, I. - Otto, S. - Schneiderbauer, S. - Harvey, A. – Hodgson, N. - Robrecht, H. -Morchain, D. - Schrander, J. - Khovanskaia, M. - Celikyilmaz-Aydemir, G. - Prutsch, A. – McCallum, S. (2010): Urban Regions -Vulnerabilities, Vulnerability Assessments by Indicators and Adaptation Options for Climate Change Impacts, ETC/ACC Technical Paper 2010/12
acm.eionet.europa.eu/reports/docs/ETCACC_TP_2010_12_Urban_CC_Vuln_Adapt.pdf

Scherrer, I. - Tobler , G. (2009): Konzept zur Siedlungsentwickung nach innen - Arbeitshilfe zur Erarbeitung der Agglomerationsprogramme - Verkehr und Siedlung, Bundesamt für Raumentwiclung -ARE; Bern
www.are.admin.ch/dokumentation/publikationen/00018/00309/index.html?

SE Consult (2009): The potential of Intelligent Transport Systems for reducing road transport related greenhouse gas emissions, special study for the EC DG Enterprise and Industry, Final report
www.ebusiness-watch.org/studies/special_topics/2009/documents/SR02-2009_ITS.pdf

Souch, C. - Grimmond, S. (2006): Applied climatology: urban climate; In.: Progress in Physical Geography 30, 2. pp. 270-279

Spanish Net of Cities for Climate. The Spanish Federation of Municipalities and Provinces (FEMP) (2007): Gestión de residuos municipales y limpieza viaria Guía Técnica, Espana;
www.asturias21.es/v_portal/apartados/apartado.asp?te=218

Spanish Net of Cities for Climate. The Spanish Federation of Municipalities and Provinces (FEMP) (2007): Primer informe sobre las políticas locales de lucha contra el cambio climático;
www.asturias21.es/v_portal/apartados/apartado.asp?te=222;

Spanish Network of Cities for Climate (2005): Estrategias prácticas a favor del clima, 2005.
www.asturias21.es/v_portal/apartados/apartado.asp?te=222

Spanish Network of Cities for Climate (2006): Cambio climático en las ciudades costeras; Madrid
www.asturias21.es/v_portal/apartados/apartado.asp?te=222

Spanish Network of Cities for Climate, web portal
www.redciudadesclima.es/;

Stern N. (2007): The Economics of Climate Change The Stern Review, Cabinet Office - HM Treasury
www.webcitation.org/5nCeyEYJr

Stockholm Environment Institute –Tallinn Centre Estonian Energy Research Institute: Country Report: Estonia Energy Efficiency and Climate Change Policy
www.resourcesaver.com/file/toolmanager/O105UF639.pdf

Subalpine Meteorological Society (2006): Cambiamenti climatici in Valle D'Aosta, Opportunitá e strategie di Risposta
www.regione.vda.it/gestione/gestione_contenuti/allegato.asp?pk_allegato=3872

Sukopp H., Wurzel A. (2003): The effects of climate change on the vegetation of Central European Cities
www.urbanhabitats.org/v01n01/climatechange_full.html

Sundberg, J. (2009): Integrated waste management in a climate change perspective - Summary of results from case studies in Sweden; Waste & Climate Conference 3-4 December 2009 Copenhagen
www.wasteandclimate.org/DocumentDownloadServlet?id=93&language=en

Swedish Environmental Protection Agency (2009): Climate Investment Programmes An important step towards achieving Sweden's climate targets; Stockholm
naturvardsverket.se/Documents/publikationer/978-91-620-8468-4.pdf

Swiss Department of Transport, Communications, Energy and Communication, (2002): Nachhaltige Mobilität; In: Forum Raumentwicklung (Informationsheft) 03./2002.
www.are.admin.ch/dokumentation/00880/index.html?lang=de&download=NHzLpZeg7t,lnp6I0NTU042l2Z6ln1acy4Zn4Z2qZpnO2Yuq2Z6gpJCDdoB_gGym162epYbg2c_JjKbNoKSn6A—

Swiss Department of Transport, Communications, Energy and Communication (2004): Räumliche Auswirkungen der Zürcher S-Bahn - eine ex-post Analyse; Bern
www.are.admin.ch/dokumentation/publikationen/00131/index.html?

Swiss Department of Transport, Communications, Energy and Communication (2007): Forschungskonzept 2008-2011: Nachhaltige Raumentwicklung und Mobilität; Bundesamt für Raumentwiclung -ARE; Bern; 2007;
www.are.admin.ch/dokumentation/publikationen/00021/00199/index.html

Swiss Department of Transport, Communications, Energy and Communication (2009): Klima und Raum im Wandel; In: Forum Raumentwicklung (Informationsheft) 3./2009.
www.are.admin.ch/dokumentation/00880/index.html?lang=de&download=NHzLpZeg7t,lnp6I0NTU042l2Z6ln1acy4Zn4Z2qZpnO2Yuq2Z6gpJCEdH94fGym162epYbg2c_JjKbNoKSn6A--

Swiss Department of Transport, Communications, Energy and Communication (2009)*:* Projekte beurteilen nach den Grundsätzen der Nachhaltigen Entwicklung; Bern
www.are.admin.ch/dokumentation/publikationen/00014/00299/index.html?

Szántó K., Sarlós J. (2009): Fenntartható település, területhasználat *(title in English: Sustainable settlement, land use)* fenntarthato.hu/epites/leirasok/telepules/telepules-terulethasznalat
Szegedi S. Baros Z. (2005): A hősziget kifejlődése és a településméret közötti kapcsolatok vizsgálata hajdúsági településeken. *(title in English: The correlation between the formation of Urban Heat Island and settlement size, in the Hajdúság)* in: Táj, környezet és társadalom *(title in English: Land, environment and society)*; University of Szeged, Department of Climatology and Landscape Ecology; Szeged. pp. 657- 665
Teich, - Lardelli, M.C. - Bebi, P. - Gallati, D. - Kytzia, S. - Pohl, M. - Pütz, M. – Rixen, Ch. (2007): Klimawandel und Tourismus: Ökonomische und ökologische Auswirkungen von technischer Beschneiung; Swiss Federal Institute for Forest, Snow and Landscape Research WSL; Birmensdorf proclimweb.scnat.ch/portal/ressources/926.pdf
Thorpe, K. (2009): United Kingdom: Cities And Climate Change. in: OECD Green Cities: New Approaches to Confronting Climate Change; OECD Workshop Proceedings, conference held 11 June 2009; Las Palmas de Gran Canaria www.oecd.org/dataoecd/46/33/45377963.pdf
Timisoara City Council (2009): Dioxidul de carbon gazul vieții sau al morții terrei; Timisoara www.dmmt.ro/uploads/files/brosuri/brosura_dioxid.pdf
Tol, R.S.J. - van der Grijp, N. - Olsthoorn, A.A. - van der Werff, P.E. (1999): Adapting to climate change: a case study on riverine flood risks in the Netherlands; Institute for Environmental Studies dare.ubvu.vu.nl/bitstream/1871/1745/2/ivmvu0732.pdf
Toledo Informal Ministerial Meeting on Urban Development Declaration, Toledo, 22 June 2010 ec.europa.eu/regional_policy/newsroom/pdf/201006_toledo_declaration_en.pdf
TranSafety, Inc.(1997): Designing Traffic Signals, In: Road Engineering Journal; October 1, 1997 www.usroads.com/journals/p/rej/9710/re971002.htm
Tübingen macht Blau - Municipal Climate Protection Campaign, web portal www.tuebingen-macht-blau.de/
UKCIP - The United Kingdom Climate Impacts Programme, web portal www.ukcip.org.uk/
UNCTAD - United Nations Conference on Trade and Development, web portal www.unctad.org
United Nations Environment Programme (2010): Annual Report www.unep.org/publications/contents/pub_details_search.asp?ID=4186
United Nations Environment Programme (2011): Green Economy Report - Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication www.unep.org/greeneconomy/GreenEconomyReport/tabid/29846/Default.aspx
United Nations Environment Programme (UNEP) (2009): Sustainable Transport - Our Planet, the magazine of the UNEP; Sept 2009*)* www.unep.org/pdf/OP_sept/EN/OP-2009-09-en-FULLVERSION.pdf
United Nations Human Settlements Programme (UN-Habitat)(2009): Climate Change Strategy 2010-2013 www.un-habitat.org/pmss/listItemDetails.aspx?publicationID=2861
United Nations Human Settlements Programme (UN-Habitat): Cities and Climate Change: An Introduction www.un-habitat.org/pmss/listItemDetails.aspx?publicationID=2958
University of Catania: Il cambiamento climatico e la città di Catania www.lapta.dau.unict.it/GRABS_presentazione.pdf
University of Leeds, Institute of Transport Studies: KonSult - Knowledgebase on sustainable urban land use and transport, Transport strategy: a Decision-Maker's Guidebook www.konsult.leeds.ac.uk/public/level0/l0_hom.htm
University of Manchester, Centre for Urban and Regional Ecology, School of Planning & Landscape (2003): Adaptation Strategies for Climate Change in the Urban Environment (ASCCUE); Manchester www.sed.manchester.ac.uk/research/cure/downloads/asccue_brochure.pdf www.sed.manchester.ac.uk/research/cure/downloads/asccue_final_report_national_steering_group.pdf
Urban and development sprawl (Draft final report)- Territorial Cohesion and Urban Matters Workgroup Thematic subgroup prepared by the Belgian delegation (Walloon Region - Directorate general Spatial planning, Housing, Heritage and Energy) November 2009
Urban Community of Lyon (2009): Diagnostic climat de l'agglomération lyonnaise - première étape vers une agglomeration sobre en carbone; Lyon www.grandlyon.com/fileadmin/user_upload/Pdf/developpement_durable/Plan_climat/Diagnostic_climat.pdf;
Urban Community of Lyon: Plan climat avenir de Lyon www.grandlyon.com/fileadmin/user_upload/Pdf/developpement_durable/Plan_climat/Plan_climat_avenir.pdf
URGE - Urban Green Environment project, web portal www.urge-project.ufz.de/
Ürge-Vorsatz, D. et al. (2010): Employment Impacts of a Large-Scale Deep Building Energy Retrofit Programme in Hungary, Central European University, Budapest 3csep.ceu.hu/projects/employment-impacts-of-a-large-scale-deep-building-energy-retrofit-programme-in-hungary
Várfalvi, J. - Zöld, A. (1994): Energiatudatos épületfelújítás, *(title in English: Energy aware building reconstruction)* La Chance Kft. Budapest

Várkonyi, E. (2008): Hulladéklerakók üvegházhatású gáz-kibocsátása *(title in English: Greenhouse gas emissions from landfills)* In: Környezetvédelem 2008./3.
Veneto Region (2006): Piano Territoriale Regionale di Coordinamento (PTRC), Rapporto Ambientale Sintesi non tecnica ptcp.provincia.venezia.it/upload/documenti/00000106/PTCPProposta_VAS_RappAmb_12Giu08.pdf
Wenzel, H. (2009): The importance of recycling in a climate perspective - Conference on Waste & Climate DAKOFA/ISWA; Copenhagen; 3-4 December, 2009 www.wasteandclimate.org/DocumentDownloadServlet?id=49&language=en
Werner P., - Zahner R. (2009): Biological diversity and cities- A Review and Bibiliography www.bfn.de/fileadmin/MDB/documents/service/Skript245.pdf
WHO Regional Office for Europe(2009): EUROHEAT project, Imporving public health responses to extreme weather ccsl.iccip.net/e92474.pdf
Wien City Council (2006): Städtische Energieeffizienz Programm (SEP) der Stadt Wien, 2006-2015 www.wien.gv.at/stadtentwicklung/energieplanung/sep/
Wolverhampton City Council (2008): Climate Change Strategy and Action Plan 2009-2012; Wolwerhampton www.wolverhampton.gov.uk/environment/climate/ccsap.htm
Woods-Ballard, B. - Kellagher, R. - Martin, P. - Jefferies, C. - Bray, R. - Shaffer, P. (2007): The SUDS manual; CIRIA; London
WWF - Italia Onlus (2009): Cambiamenti climatici, ambiente ed energia, Linee guida per una strategia nazionale di mitigazione e adattamento, marzo; Roma www.wwf.it/UserFiles/File/News%20Dossier%20Appti/DOSSIER/dossier%20clima/Linee%20Guida%20WWF%2010%20marzo.pdf
WWF Italy, Scientific Committee (2007): Per un piano di adattamento al cambiamento climatico in Italia, Prime indicazioni di Massima; Rome www.consumieclima.org/download/adattamento_ai_cambiamenti_climatici.pdf
YTV Helsinki Metropolitan Area Council: Helsinki Metropolitan Area Climate Strategy to the Year 2030 www.energy-cities.eu/IMG/pdf/ilmastostrategia_tiivistelma_eng_small.pdf
Zaragoza City Council (2009): Climate change and air quality improvement strategy of Zaragoza www.zaragoza.es/ciudad/medioambiente

Index