HANDBOOK

Climate change planning

for regional and local authorities

EnercitEE

INTERREG IVC
INNOVATION & ENVIRONMENT
REGIONS OF EUROPE SHARING SOLUTIONS

European Union
European Regional Development Fund

EnercitEE – SubProject CLIPART

CLImatic Planning And Reviewing Tools for regions and local authorities

HANDBOOK

Climate change planning
for regional and local authorities

2012

Authors

Vittorio Marletto, *Arpa Emilia-Romagna, Italy*

Henrik Johansson, Anna Petersson Max, *City of Växjö, Sweden*

Emilie Prouteau, Guillaume Brulfert, Didier Chapuis, Eric Chaxel, Isabelle Girerd *Air Rhône-Alpes, France*

Antje Fritzsche, Karin Röser, Matthias Schucht *Saena, Dresden, Germany*

Piotr Klementowski, *Jelenia Góra, Poland*

Acknowledgements

The authors are deeply indebted for their help with:

Lucio Botarelli, Barbara Ramponi, Lucia Pirro, Valentina Pavan, Paolo Cagnoli, Michele Sansoni *Arpa Emilia-Romagna*;

Stefano Valentini *Aster*;

Attilio Raimondi *Region Emilia-Romagna - Assessorato Attività Produttive, Commercio, Turismo*;

Andreas Völlings *Saxon State Office for Environment, Agriculture and Geology;*

Michel Danielou, François Wurtz *General Council of Haute-Savoie.*

Issued by:
Arpa Emilia-Romagna
Servizio IdroMeteoClima
Viale Silvani, 6 - 40122 Bologna, Italy
e-mail: vmarletto@arpa.emr.it
web: www.arpa.emr.it/sim

Layout:
Omega Graphics Snc di Maurizio Sanza e Laura Grassi
Via Franco Bolognese 22 - 40129 Bologna - Tel. 051.370356
e-mail: info@omegagraphics.it

Printed by the Regional Printing Centre of Emilia-Romagna, November 2012

Contents

Preface

This handbook is the final report of **Clipart**, a two-year subproject of the **EnercitEE** initiative (www.enercitee.eu), supported by the **Interreg IVC** programme of the European Union, providing funding for interregional cooperation across Europe (www.interreg4c.eu).

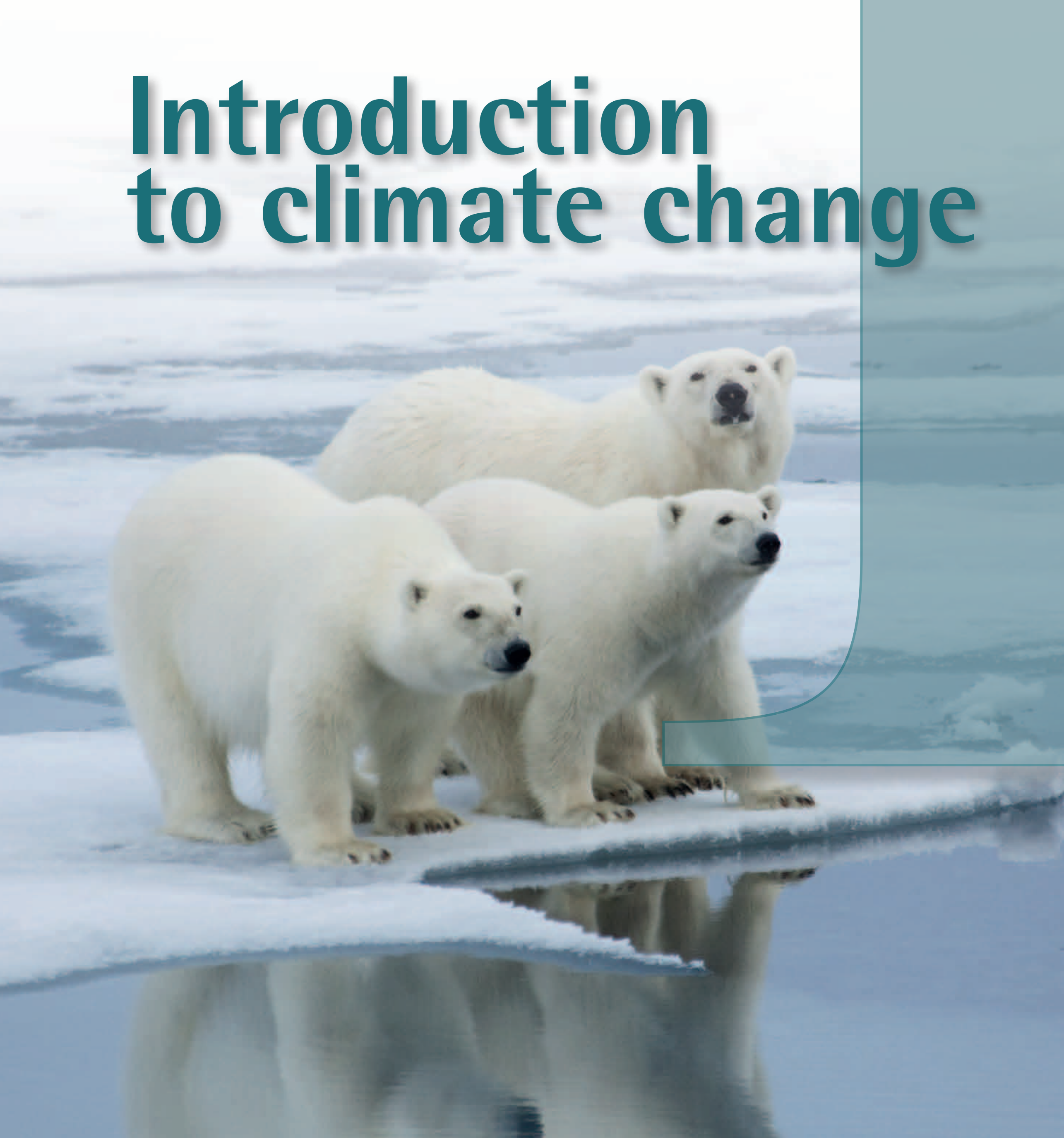
EnercitEE means "European networks, experience and recommendations helping cities and citizens to become Energy Efficient" and is a four year miniprogramme based on cooperation between five European regions (**Saxony, Emilia-Romagna, Haute Savoie, Småland** and **Lower Silesia**) in five EU countries (resp. Germany, Italy, France, Sweden and Poland).

The Clipart subproject was carried out by agencies and local authorities from the five EnercitEE regions, see www.enercitee.eu/clipart for details.

The same web page contains a downloadable Initial Report, produced by the Clipart subproject in 2011 and presenting a collection of more than 50 examples of acts, projects and other items shortly describing activities connected with climate change and climate planning in the five EnercitEE regions.

Chapter 1

Introduction to climate change



1.1 Why should you read this handbook?

Are you a European local or regional administrator? Are you working in close cooperation with regional/local administrators, supporting them in policy making? Then this handbook is for you!

If you are not a local or regional administrator don't worry, this handbook could be useful for you anyway, especially if you are advocating for climate change policies, or trying to raise interest on the climate issue in local or regional administrations, and in general if you are a European citizen interested and active in local/regional politics and policies.

This handbook contains a broad and not too technical description of the climate change issue (this chapter), and describes a number of supporting procedures and tools for local/regional administrators that want to know more about climate change, or are planning to put the climate issue in their policy agenda, for mitigation (i.e. cutting greenhouse gas emissions, chapter 2), adaptation (i.e. understanding and managing impacts of climate change on environment and society, chapter 3), or both.

1.2 What is climate change about?

About thirty years ago, October 1985, a group of scientists gathered in a room near Villach, Austria, and issued a general warning to United Nations, saying something like this:

"*Beware, we are polluting the atmosphere so much that the climate is changing, and the change could go on and get really dangerous for humanity, we should all do something about it*".

Most of the scientists in Villach were climatologists, so expert about Earth's climate that they could model it and run the models in computers. Their early predictions of an impending global warming have been confirmed by weather data collected ever since: the world is indeed warming up at a worrying rate (Figure 1.1).

Some years after the Villach warning the United Nations established to the Intergovernmental Panel on Climate Change (IPCC), an international scientific commitee issuing every five years or so a large report on climate change (www.ipcc.ch). The last report available is dated 2007 and a new one (the fifth) is due in 2013/14.

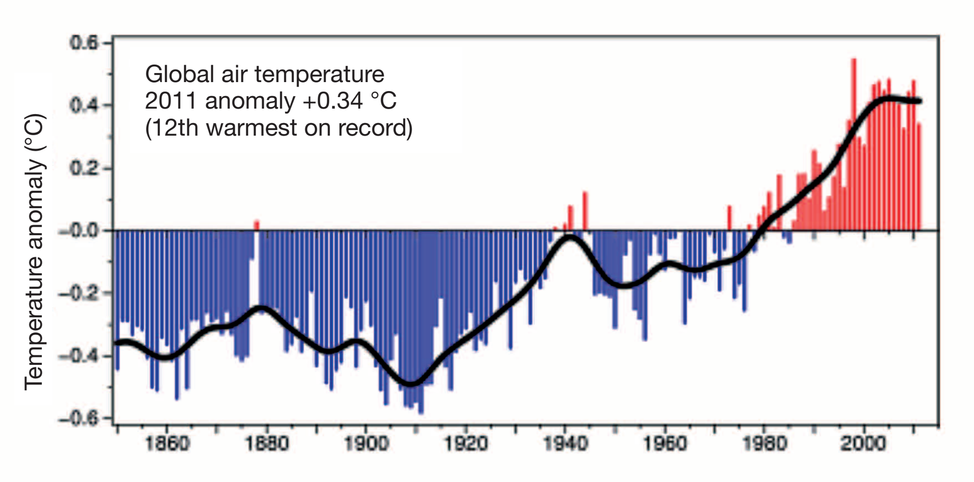


Figure 1.1 This graph, produced and yearly updated by the Climate research unit of the university of East Anglia, UK, shows what is happening to the Earth's temperature. Data from all over the world say that in the last 25 years or so the world has been consistently warmer than before, and that temperature now is about 0.8 degrees higher than one century ago (www.cru.uea.ac.uk).

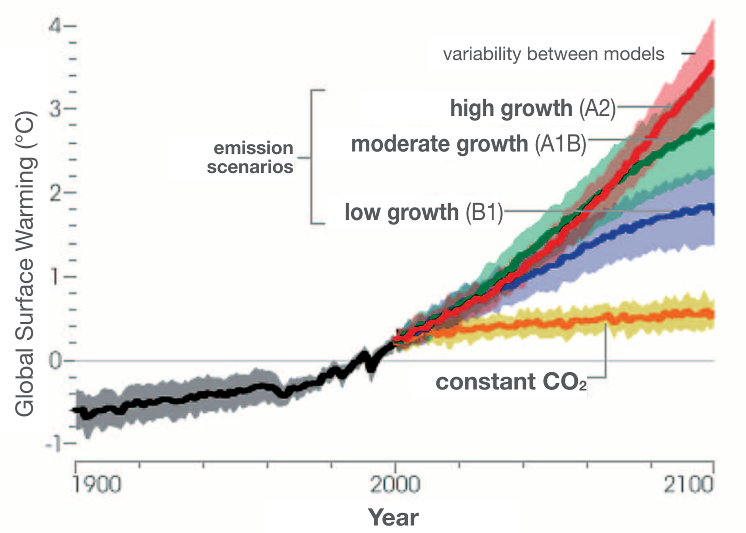


Figure 1.2 This graph, taken from the fourth IPCC report via the epa.gov web site, illustrates what will possibly happen to the Earth's temperature during the 21st century according to climate models, for a number of CO_2 emission scenarios.

IPCC reports contain an enormous amount of data and information but perhaps the most important thing they give is a picture of the possible future Earth climate scenarios (Figure 1.2).

The IPCC report states that the ongoing warming and the foreseen trends are due most likely to human emissions of greenhouse gases like CO_2 (carbon dioxide).

If you are already an expert on terms like greenhouse effect, greenhouse gases and carbon dioxide you can skip the following sections where we give some explanations about these terms.

1.3 What are the greenhouse effect and greenhouse gases?

The empire of the sun

The Earth's climate is dominated by the sun. Every moment a huge amount of energy reaches the Earth as sunlight, so much that in one hour we get more energy than the consumption from the whole humanity in one year.

The Earth reflects to space some of the energy received from the sun and re-emits almost all the rest in the form of infrared radiation. This energy balance is roughly sketched in Figure 1.3.

However this is not the whole story. Consider the moon, more or less at the same distance of Earth from the sun and with a similar radiation balance, but with a mean surface temperature of about -20 °C, well below freezing point. These conditions alone make life as we know it impossible on the moon.

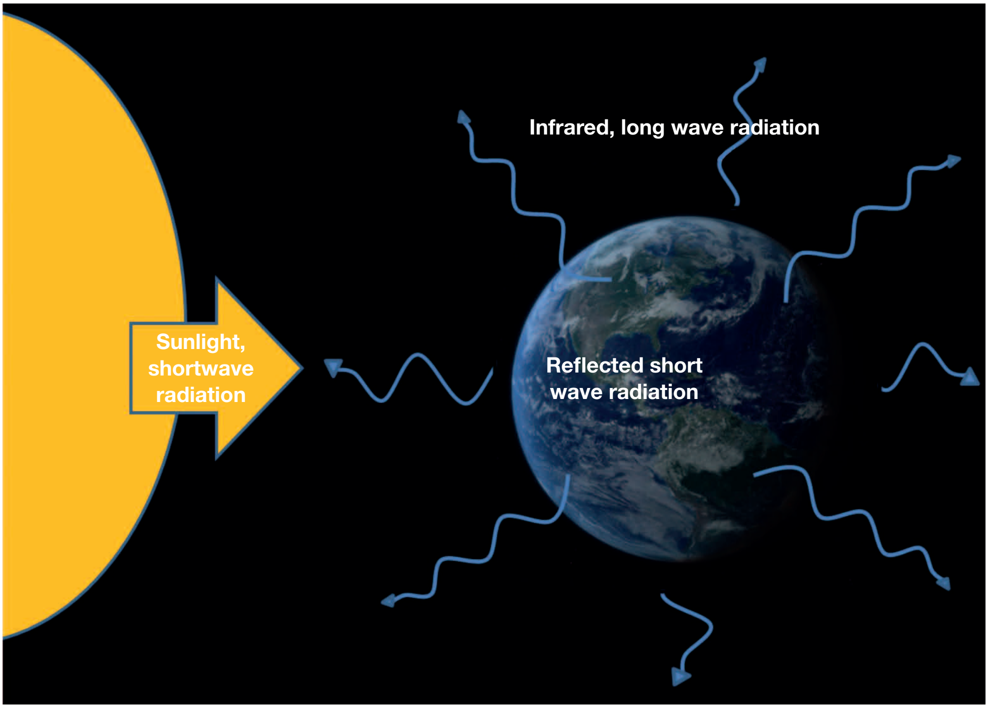


Figure 1.3 Radiation balance of the Earth: the energy coming from the sun as shortwave sunlight, is partly reflected, while the rest leaves the planet as long wave infrared radiation, emitted in all directions and in the same amount.

The role of the atmosphere

The point of course is that Earth has an atmosphere, a thin but very important gas layer mostly composed by nitrogen and oxygen (99% of its dry volume). These two gases however have no climatic relevance, as they scarcely interfere with the radiation balance.

Minor components of the atmosphere called greenhouse gases (GHGs) are instead the main characters of the climate play.

The most important GHG is not carbon dioxide as one could guess, but water vapour! Water in the atmosphere is present in always variable amounts, in the form of solid ice (in very high clouds, hail, snow, etc.), liquid (in lower clouds, raindrops, fog etc.), and vapour.

Water vapour is absolutely invisible, that is light goes through it without any consequence, but very active in the infrared, i.e. it interferes with long wave radiation leaving the Earth's surface, so much that the surface temperature must rise to keep the radiation balance.

Water vapour and the other GHGs are so effective that the average temperature of the Earth is about 35 degrees higher than the moon's, i.e. about 15 °C, well above freezing point. So one thing should be clear, the greenhouse effect is not bad, we owe our life to it. But you can have too much of a good thing, as on planet Venus, where very high CO_2 amounts in the atmosphere produce a surface temperature well above 400 °C!

The concentration of water vapour in the air can be as high as 3%, about one hundred times higher than CO_2. So what's the point with CO_2? Well, the point about this GHG is clear when you see how its concentration is rising since the start of regular measurements (Figure 1.4), a trend not visible in water vapour. Values of CO_2 are now reaching 400 ppm (parts per million) while according to samples taken in Antarctica its value never went above 280 ppm in the last 800,000 years!

IPCC reports show that other GHG gases like methane and nitrogen dioxide are on the rise, with even steeper trends than CO_2. All these trends are anthropogenic, i.e. due to human activities - mainly combustion of fossil fuels and deforestation for CO_2 - industry and agriculture for the rest.

Confusing gases

Some in the public tend to confuse global warming with the ozone hole. The latter is a severe depletion of the stratospheric ozone layer near the poles due to CFCs (chlorofluorocarbons), a specific class of gases invented by humans and used mainly in fridges and in spraying cans. The ozone layer is essential in protecting life from the dangerous solar ultraviolet (UV) rays, so an international treaty is dealing with this specific issue, essentially prohibiting the production and release of CFCs in the atmosphere.

The confusion arises maybe from the fact that CFCs are also potent greenhouse gases. They are in fact also regulated by the international convention on climate change (UNFCCC) and the Kyoto protocol (see below for more details).

1.4 What are the sources and sinks of GHGs?

Carbon dioxide

Carbon is fundamental for life, in particular carbon dioxide from air is essential for the growth of plants both on land and sea. Plants and green algae capture carbon dioxide from air and convert it to sugar, in a process called photosynthesis. In plants and algae, sugar is then converted in all sorts of substances and when plants and algae are eaten by animals the carbon from the air enters their bodies (and ours!).

Carbon dioxide is also lost to the air from plants and animals in a process called respiration, essentially the reverse of photosynthesis, and also by microorganisms that take care of decomposition of dead organic matter, so you can see that carbon is cycling on the planet in a complex manner.

Another important element of the carbon cycle is the dissolution and exhalation of CO_2 from the oceans: all gases can stay dissolved in liquids, but when temperature rises, the amount dissolved lowers, as shown for instance by the tiny bubbles you find in the morning in the glass of water you took from tap before going to bed.

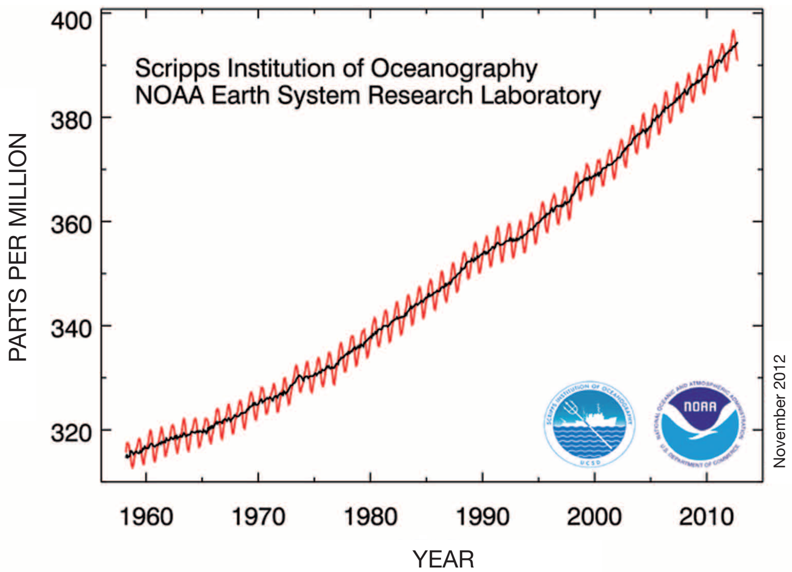


Figure 1.4 The growth of carbon dioxide concentration measured by American scientists in Mauna Loa, Hawaii. This graph is representative of the whole atmosphere and shows the natural yearly oscillation of the gas (red) and an exponential trend (black). Every year the concentration of CO_2 grows about 2 ppm (parts per million). Before industrial revolution the value was around 280 ppm. *(www.esrl.noaa.gov/gmd/ccgg/trends/)*

The great natural cycle of carbon is essentially in equilibrium, but here comes a new actor, humans. Burning fossil fuels, as we do in large amounts, perturbs the equilibrium: not all the carbon emitted by humanity in the air can be absorbed by natural "sinks" such as the oceans and soils (where a lot of carbon accumulates for instance in forest soils when leaves fall and old plants die). Human made carbon emissions arise also from the disturbance of natural organic soils (e.g. ploughing of tropical soils after clearing of rainforest).

Another relevant source of carbon dioxide derives from the production of cement. The chemical reaction taking place in the process results in substantial emissions of CO_2. Every ton of freshly produced cement emits about one ton of CO_2 including energy costs.

Roughly half of the human emissions of CO_2 cannot be absorbed by the Earth so the air concentration of this greenhouse gas is now rising at the unprecedented rate of about 2 ppm/year (Figure 1.4).

Other sources

Greenhouse gas emissions from energy consumption are more than half the total, the rest comes from all sort of factors.

Methane is lost from oil wells, natural gas fields and coal mines, it is emitted from not properly managed landfills where organic matter is decomposing, from rice pads and from dam basins in the tropics, and also from cattle (in general ruminants emit methane during digestion of cellulose contained in the plants they feed on).

Nitrous oxide is emitted from agriculture, due to excess nitrogen fertilisation of agricultural fields. Though this gas is present in parts per billion, it is relevant because it has a high warming potential (over 300 times higher than CO_2).

1.5 What is the relation between energy and climate change?

Humanity is using an ever growing amount of energy, most of which is obtained burning carbon based substances extracted from underground like coal, crude oil and natural gas. Energy is mostly used for production, transport and heating/cooling of buildings.

In 1950 the energy used per person was about 0.6 TOE/year, in year 2010 it was beyond 1.8. You have to add to this that in 1950 there were 2.5 billion humans on Earth, and now we are 7 billions!

Energy efficiency is very important in this respect, meaning using less energy per unit of GDP or per person keeping the same level of welfare. One striking example is the substitution of incandescence with fluorescence lamps, generating the same illumination with about one fourth of the electricity needed.

1.6 How is climate change impacting the world?

The world is undergoing a vast change due to anthropogenic climate change. First of all there is the temperature rise, which is generally producing distinctly warmer seasons in the temperate and northern areas of the planet with shortening of the snowfall periods, reduction of snow duration, longer and hotter summers, and more erratic season changes with more unpredictable onset of the rainy spells, and longer droughts. The warming climate is affecting natural life, with measurable reductions in plant development cycles, migration of species towards mountain tops and the north, effects on migrating birds travelling and nesting habits, etc.

Ice deposits in the world are obviously hit by the general warming, as the pictures of disappearing white top of the Kilimanjaro dramatically show. In the European Alps glaciers facing south and lying below 3,000 m above sea level are retreating fast. The extent and thickness of the Arctic Ocean pack of floating ice is decreasing at unexpected rates, and some researchers think that in a few years there will be no more ice floating on the North Pole at the end of summer. Clearly this is in turn affecting the warming rate of the northern ocean as ice reflects sunshine while water tends to absorb it.

The global ocean is also showing effects from the warming, with a 3 mm/year rise due to continental ice melting and ocean thermal swelling. Another important effect on oceans is the rise of water acidity, due to increased amounts of CO_2 being absorbed by water. More acidic waters are less favourable to marine life, e.g. to the flourishing of coral reefs. Remember also that most of the atmospheric oxygen comes from the ocean.

1.7 How is climate change impacting your community/region?

Some of the global warming effects result in changes in your local climate, wildlife, agriculture, population health conditions and so on. That of course depends a lot also on the geographical situation of your region/community. Mountainous areas experience very different climate change impacts from coastal areas, as do cities compared with the countryside.

Impact studies are very important to carry out, especially in the framework of adaptation to climate change. They must be based on sound knowledge of both downscaled climate projections and the local geographical, social and economic situation. They usually include evaluations on the evolution and impacts of extreme weather events like hurricanes, floods, droughts, heat waves and so on.

Analyses of locally measured climatic data up to present are also important to evaluate current trends e.g. in temperature and precipitation (Figure 1.5). Records of vegetation and animal phenology (flowering dates, bird migrations etc.) kept by universities and other observers are also important to mark on-going changes in natural life.

One of the most important factors of local welfare is water availability. This is to be examined with special attention to changes in consumption, availability, sources and losses. The local water cycle is often affected very much by climate changes even in remote regions, especially where large rivers flow or in areas characterised by large aquifers influenced by precipitation and glaciers in distant mountain ranges.

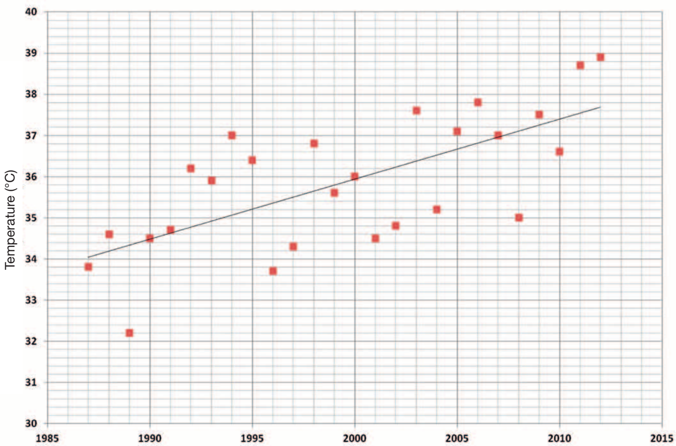


Figure 1.5 The impressive rise of yearly absolute maximum temperature measured near Bologna, Italy, in recent years (Sant'Agata Bolognese, 1987-2012, source Arpa).

1.8 Who is taking care of climate change and why?

The United Nations have a number of important organisations caring for climate change. Let's start with WMO (World Meteorological Organisation), an agency that is part of the UN from 1951, with headquarters in Geneva, Switzerland. It governs meteorological and climate data collection and their international exchange. WMO chairs, together with the UNEP (UN Environmental Programme) the organisation and funding of IPCC.

IPCC (Intergovernmental Panel on Climate Change) is a cooperative scientific organisation, founded in 1988, reviewing global scientific literature on climate change, impacts and mitigation issues, drawing emission scenarios of anthropogenic greenhouse gases and issuing projections about the future of the climate on Earth. IPCC issues with irregular periodicity its influential evaluation reports, the fourth was published in 2007 and the next is due in 2013/14.

UNFCCC (United Nations Framework Convention on Climate Change) is a body of the UN established in Bonn, Germany, and presiding over the implementation of the Framework Convention on Climate Change, adopted in 1994. The Convention is implemented by means of agreements signed in periodic international conferences, the most important of which launched in 1997 the so called Kyoto Protocol. All countries that are committed to the Protocol report to the UNFCCC about their emissions in yearly official reports. Emissions are recorded according to standards minutely defined in technical reports by the IPCC.

The Kyoto Protocol is an international treaty signed in Kyoto, Japan, in 1997, implementing the Framework Convention on Climate Change, which provides for reductions in emissions of greenhouse gases in the signatory countries and the return to levels below those of 1990 within the five years 2008-12. The overall target for the signatories is a reduction of 5.2%, but all countries have individual targets.

For example Italy should decrease emissions 6.2% compared to 1990 emissions, a level slightly higher than that of the general protocol but lower than the overall European Union, which ranks to -8%.

The Protocol entered into force in early 2005 with the ratification by Russia, which allowed reaching the 55 ratifying countries and 55% of the emissions subject to reduction. The United States and other industrialised countries, who had also signed the Framework Convention and the Protocol, have subsequently refused to ratify it, fearing too strong repercussions on their domestic industrial system. In addition to the actual reduction of emissions, the Protocol, at the time the subject of a hard negotiation, involves complex exchange mechanisms (emission trading), and reduction of emission quotas in exchange for clean energy projects in third countries (Clean Development Mechanism) or JI (Joint Implementation) between signatory countries and third countries.

The protocol, despite being the first concrete example of an international effort aimed at reducing greenhouse gas emissions, is considered by many largely insufficient for limiting the global temperature increase within two degrees in 2100 and a new agreement is expected to follow in a few years, also involving the U.S. and newly industrialised countries and large emitters like China, India and Brazil.

In Europe the subject matter of climate change is surveyed by the European Environment Agency based in Copenhagen, Denmark. The EU pledged to higher objectives of emission cuts than required by the Kyoto Protocol, but for years 2020 (-20%) and 2050 (-80%). The matter is regulated by the so called energy-climate pack, officially launched in 2009.

1.9 Why is all this relevant for a local administrator?

Citizens appreciate politicians that show competence and willingness to act on complex issues, with a clear orientation toward protection of citizens' lives, property and their environment at large.

Climate change clearly has impacts on land and the community both at the regional and local levels, and impacts are expected to grow in the future, so it should be considered relevant for administrators willing to protect their citizens from financial losses, health problems and even casualties.

Specific studies, like the famous Stern Review report of 2006, made clear that early commitments are both more effective and cheaper than late action and that the cost of inaction in the face of adaptation to climate change can rapidly become prohibitive.

Communities are also an active part in the climate problem contributing with GHG emissions to the atmosphere from households, transport, and production activities. That's why European laws transfer the burden of emission cuts on local administrators that have a duty to set up plans for mitigation, e.g. cutting emissions from their areas.

1.10 What should you do as a local administrator?

Regional and local administrators can take advantage of this handbook, providing a simplified but complete picture of the climate change issue together with guidelines to act for planning and reviewing plans in mitigation and adaptation.

Making a regional/local action plan for climate change is not an easy task but it can be done as shown by some examples in Europe. Reviewing existing plans in view of improving their effectiveness and efficiency is also important and the handbook gives some help also in this respect.

So go on to the following chapters that will help you to commit yourself and your administration in climate planning.

1.11 What is mitigation?

In the climate jargon mitigation identifies and implements the best methods for reducing emissions of greenhouse gases in the atmosphere so as to reduce the human impact on Earth's climate.

IPCC devoted to this subject the entire third volume of its evaluation report, where they list seven main sectors of human activity where mitigation measures are possible: energy, transport, buildings, industry, agriculture, forestry and waste management.

For each sector they describe currently available methods for mitigation, and also some methods that are still under development but that could become available in due course. As an example of an already available method we can mention wind farms and photovoltaic power plants.

Chapter 2 of this handbook is devoted to mitigation.

1.12 What is adaptation?

Countries, organisations and people all over the world are working to reduce emissions to prevent catastrophic climate change. But the historical and current emissions mean that we cannot completely avoid change and its consequences.

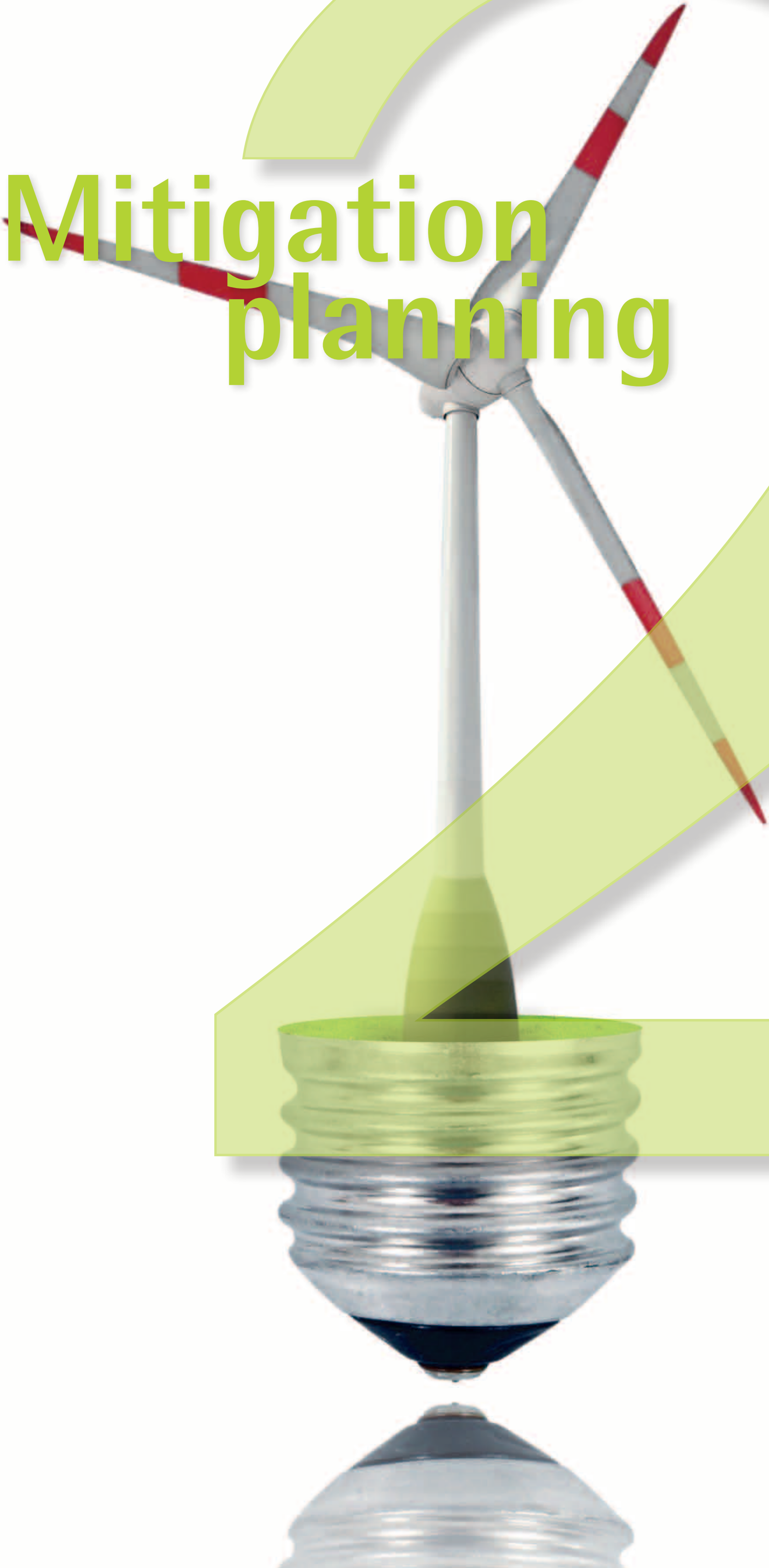
The climate has always been influenced by natural processes that give variations between warmer and colder periods in a longer perspective of thousands of years. But the changes taking place now are unique in that they happen so fast, have great scope and are expected to have far reaching effects. The normal adaptation, both within natural and social systems, simply cannot keep up.

Climate change affects virtually all sectors of society, our ecosystems, our natural and cultural environment and our health. Central authorities, county councils, municipalities, businesses and individuals are all affected by climate change and also have a responsibility to manage the challenges and opportunities that they bring. We must adapt to new conditions in all sectors of society and that is what adaptation is about.

Chapter 3 of this handbook is devoted to adaptation.

CHAPTER 2

Mitigation planning



2.1 Introduction

Climate change is one of the most debated environmental topics on international levels, and even if climate change is a global challenge, many local and regional authorities have already understood that they play important roles when it comes to climate mitigation. Once you exclude long range international transport, the total emissions of global greenhouse gases are the sum of emissions from municipalities and regions. Also, it is often easier to start working on local and regional level, than waiting for international agreements and national legislation. However, for a successful and long lasting local or regional climate work, the introduction of a climate policy based on political decision, long term targets, cooperation with stakeholders, together with action plans and a system for follow-up and evaluation, is crucial. This chapter will deal with these aspects, since they are the fundaments of a local and regional mitigation of climate change.

All municipalities and regions have specific contexts that influence the way they contribute to the climate change. In some regions, energy production or transport may be the biggest source for the GHG emissions, while agriculture or industry may be the biggest source elsewhere. It is also important to consider that each country is unique, with its own legislation, level of centralisation and environmental strategies. These factors impact on the possibilities local and regional authorities have to actually adopt climate strategies, and what they will finally look like.

The two following sections show a selection of basic elements and essential tools which enable the municipalities to act in the area of regional mitigation. They are no mandatory requirements for every municipality, but they offer great opportunities to act.

2.1.1 Basic elements

The basis for each planning of emission savings is empirical data about the investigated area and as second step the consumption of energy from different sources in the area. Only with an adequate basis of information valid statements and recommendations regarding a municipality's mitigation strategy can be made.

In general it is necessary to consider data at the municipality or regional level in addition to national level data to get valid statements about the emissions of municipalities and regions. Above all the data needs to be analysed in order to compile an **energy balance** which in turn is a first step towards a **CO_2 balance** and possibly a **life cycle assessment** (LCA).

Table 2.1 lists required information and possible data sources for the planning of mitigation measurements.

Table 2.1 Essential data and different data sources. Example of Germany.

Basic data	Data sources	
Demographic data	Population and future trend, age distribution, subdivided into suburbs or districts	Regional statistic agencies
Urban structure	Building typology, building age classes, i.e. before 1835, 1835-1870 . . . 1995-2001, 2002 – today and trend, number of buildings, esp. public buildings	Local statistics, Regional statistic agencies, Germany: Institut für Wohnen und Umwelt Darmstadt (IWU)
Social structure	Employment, unemployment, household size	Regional statistic agencies
Geographical structure	Land use and it's geographical distribution, nature conservation restrictions etc.	Regional statistic agencies, regional development plan, maps
Economic data	Number of companies, ratio between branches, like industry, trade and services, agriculture and forest, public sector	Regional statistic agencies
Data on heating systems	kind of heatings systems and their ratio	Local chimney sweepers
Transport structure	Data on streets, cycle tracks, public transport system	Municipality
	Admission numbers, number in relation to population	Federal motor transport authority
	Driving performance	Federal ministry of transport
	Modal split data	Federal ministry of transport or other empirical quantified publications
	Public transportation, number of passengers	Public transportation companies
Energy production and consumption		
Energy production	Production in each power plant, compact data on small scale installations (i.e. photovoltaic)	Energy suppliers, grid operator
Grid-bound energy sources	Electricity	Energy provider
	Gas	Energy provider
Non grid-bound energy sources	Oil	Energy provider
	Coal	Energy provider
	Renewables, esp. biomass	Energy provider or producer
District heating transport	District heating	Energy provider or producer
	Fuels	Sales statistics fuel provider

Data is needed on different areas of a municipality and higher levels, as well as information on private companies and households. Therefore the data has to be procured at several data sources, like statistic agencies, energy utility companies or network operators. Some data might not be available, then calculations and approximations are necessary. On the level of the public sector the data from the municipality's energy management system has to be provided.

Weather adjustment:

As weather conditions have a significant influence on heat energy consumption, a **weather adjustement** needs to be carried out in order to make heat energy consumption data from different years or regions comparable, as follows:

1. Assess the annual consumption
2. Determine the specific climate factor considering your local position and the relevant period (Germany: online available www.dwd.de/klimafaktoren)
3. Multiply your annual consumption with the climate factor

Table 2.2 Example of the weather adjustment for the City of Dresden

Weather adjustment according to VDI (Association of German engineers) guideline 3807

1. Days with outdoor temperature below 15°C ➠ that means heating is needed
2. Difference between indoor temperature of 20°C and the real outdoor temperature at that day
3. Total sum of all temperature differences for a certain period
4. The relation of the degree days to the longterm mean indicates the heat energy consumption for an average period. ➠ The higher the value, the colder was that period and the higher was the need for heating.

Year	2005	2006	2007	2008	2009	2010	2011
Degree days	3,784	3,603.0	3,379.0	3,496.0	3,640.8	4,271	3,381.2
Factor	0.96	1.01	1.08	1.04	1.00	0.85	1.08
Average				3,650.71			

Only after a weather adjustment it is possible to analyse if there was a real change in behavior, or mitigation measures were successful, or if variation of energy consumption was caused by weather variabilities.

2.1.2 Scenarios

Scenarios are alternative visions of how the future might unfold. Scenarios are an appropriate tool to analyse how driving forces may influence future emission outcomes and to assess the associated uncertainties. They assist in climate change analysis, including climate modelling and the assessment of impacts, adaptation, and mitigation. The possibility that any single emissions path will occur as described in scenarios is highly uncertain because future GHG emissions are determined by many uncertain influencing factors like demographic development, technological change or socio-economic development. Scenarios are no forecasts but rather demonstrate the maximal scope of action and the resulting emissions. Scenarios are able to support the definition of targets for emission reductions. They help to assess the areas where emission reductions are possible, cost effective and feasible.

Owing to the wide range of different factors which could influence the emission level in the future it is useful to display different scenarios. At least two types of scenarios, a minimal (minimum efforts) and a maximal (maximum effort) scenario should be applied.

The scenarios could be accompanied by further details reflecting the part of the relevant factors which can be influenced by the municipalities themselves, as in the following.

Business as usual (BAU) or trend scenario: describing how the level of emissions would develop without any extra effort regarding mitigation. The impacts of foreseeable or already started measures or regulations to reduce emission will be anticipated in this scenario.

Climate scenario: displaying how the level of the emissions would develop within the framework of an ambitious climate policy with measures at all levels of the society. In this scenario all energy saving potentials are utilized. To implement this scenario all levels of public administration, from local authorities to the EU, have to push activities of emission reduction.

2.2 Essential Tools

2.2.1 Energy balance

An energy balance displays the flow of energy from all sources, from production to conversion and consumption. The balance provides essential perceptions about quantities and structure of energy consumption and its shift can be metered. The energy balance informs about the input of internal and imported energy carriers and about the distribution of energy to different sectors of consumption. Figure 2.1 shows the structure of the national energy balance of Germany, as an example. There are four main steps with several subdivisions to display the energy use. It attaches the consumption of primary energy carriers through the energy consumption to the specific sectors of the society.

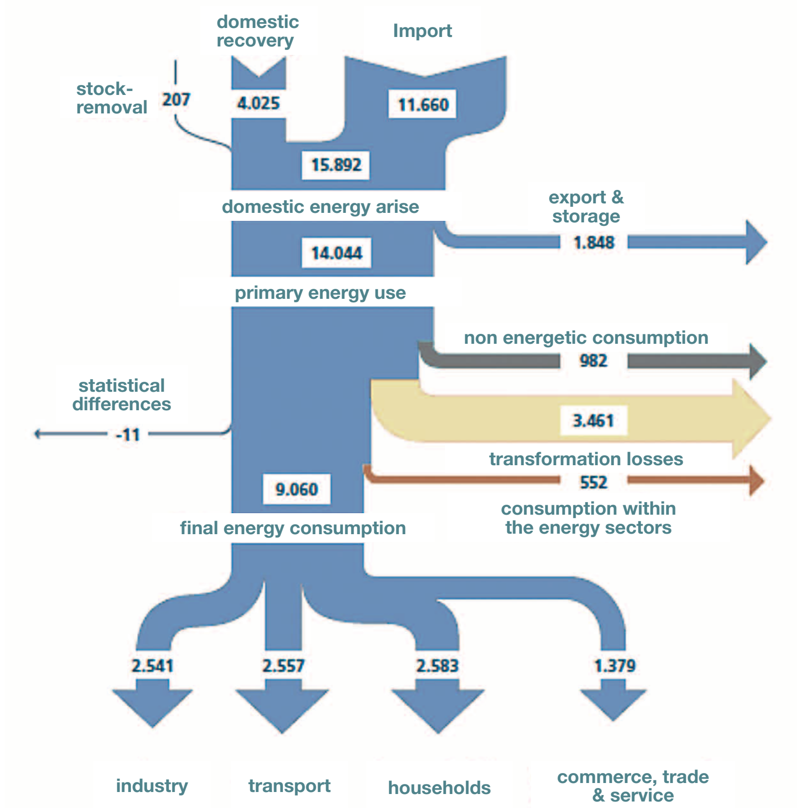


Figure 2.1 Energy flow (Sankey chart) Germany 2010. Source: Arbeitsgemeinschaft Energiebilanzen 07/2011.

But decisive for politics in municipalities is the level of the **final energy consumption**. The final energy consumption consists of the energy consumption in the areas mining and quarrying, manufacturing industry, transport, households and trade, commerce and services. The energy balance displays in which sector which volume of an energy carrier is consumed so it enables to identify potentials of improvements within the municipality area.

However, energy balances are an essential requirement for political and economic decisions and are basic requirement for creating a CO_2- balance or an LCA analysis.

2.2.2 CO_2 Balance

The leading indicator for greenhouse gas inventories is CO_2. Therefore often "only" CO_2 inventories or CO_2 balances are mentioned. A CO_2 balance shows the overall amount of carbon dioxide emissions from energy use within a certain area. As Figure 2.2 illustrates, about 80% of all greenhouse gas emissions within the EU are energy-related. These emissions are produced during the conversion and use of fossil fuels on various stages and in different sectors.

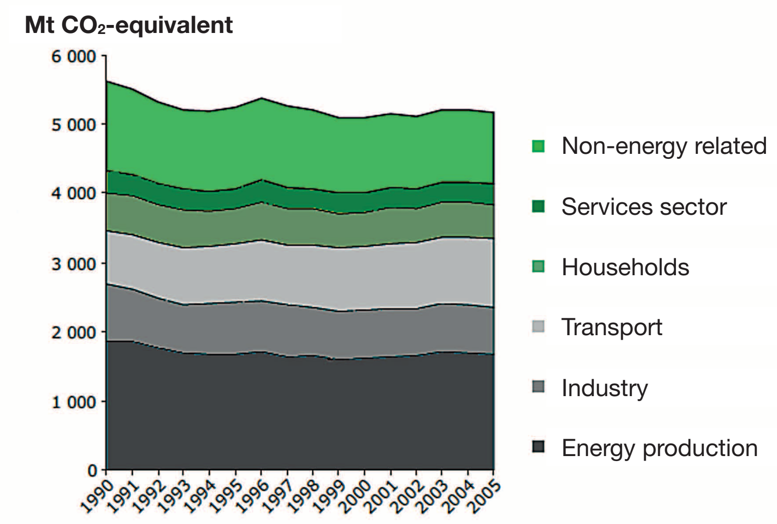


Figure 2.2 Total energy and non-energy related greenhouse gas emissions by sector, EU-27. Source: European environment agency 2011: EN01 Energy related greenhouse gas emissions, p.2.

A CO_2 inventory is based on a energy balance, as introduced in the previous chapter. It converts the final energy consumption into CO_2 emissions. The CO_2 balance offers the municipalities a clear opportunity to compile the emissions from different sources of their whole area and attach them to defined sectors. Finally the CO_2 balance enables the municipalities to identify sectors with potential for improvements to reduce the CO_2 emissions.

2.2.3 Emission factors and CO_2 equivalent table

The essential link between the energy balance and the CO_2 inventory are emission factors. Emission factors are coefficients quantifying the emission per unit of activity. The emissions are estimated by multiplying the specific emission factor with corresponding data from energy balance. The CO_2 emissions that occur due to energy consumption within the territory of the local authority can be calculated with the "standard" emission factors by applying the IPCC principles. An important but often misunderstood fact is that electricity and district heating produced outside the area of the municipality do not emit CO_2 in that area.

The **standard CO_2 emission factors** are based on the carbon content of each fuel as defined in the context of the UNFCCC and the Kyoto protocol. Related to that approach only CO_2 is calculated because it is seen as the most important greenhouse gas while N_2O and CH_4 are not considered. Besides, the CO_2 emission factor for biomass or biofuels are considered to be zero. The standard emission factors are based on the IPCC 2006 Guidelines.

However, the local authority may decide to use also other emission factors that are in line with the IPCC definitions. So other greenhouse gases, like N_2O and CH_4, can be taken into consideration by using the Global Warming Potential approach. A factor converts these emissions into **CO_2 equivalents**.

Table 2.3

Global Warming Potentials (CO_2 equivalents of CH_4 and N_2O)	
Original compound	CO_2 equivalent
1 t CO_2	1 t CO_2-eq
1 t CH_4	21 t CO_2-eq
1 t N_2O	310 t CO_2-eq

If the methodology chosen by the municipality only counts CO_2 emissions, then emissions can be reported simply as t CO_2.

Another approach are emission factors that take the overall life cycle of the energy carrier into consideration. These so called **LCA emission factors** follow the idea of the Life Cycle Assement Analysis (LCA), which will be explained in the next chapter. This includes not only the emissions caused by the final consumption but also all the emissions caused by all parts of the supply chain like exploitation, transport and processing. That means not only emissions that occur outside the municipalities area are balanced, but also emissions from the use of biomass or biofuels are higher than zero.

Also within the LCA approach other greenhouse gases than CO_2 may play an important role. The local authority that decides to use these extended LCA approach may report emissions as CO_2 equivalents.

Table 2.4 Selected Standard CO_2 Emissions Factors. Source: IPCC Guidelines for National Greenhouse Gas Inventories, 2006. Available at http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html.

Standard CO_2 Emissions Factors (IPPC, 2006) and CO_2-Equivalent LCA Emission Factors (ELCD)		
Type	Standard Emission Factor [t CO_2/MWh]	LCA Emission Factor [t CO_2-eq/MWh]
Lignite	0.364	0.375
Anthracite	0.354	0.393
Motor Gasoline	0.249	0.299
Gas Oil, Diesel	0.267	0.305
Biodiesel	0	0.156
Residual Fuel Oil	0.279	0.310
Natural Gas	0.202	0.237
Municipal Waste	0.330	0.330
Wood	0 - 0.403	0 – 0.405

Table 2.5 Standard CO_2 Emissions Factors for electricity in different countries. Source: IPCC Guidelines for National Greenhouse Gas Inventories, 2006. Available at http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html.

National and European emission factors for consumed electricity		
Country	Standard Emission Factor [t CO_2/MWh]	LCA Emission Factor [t CO_2-eq/MWh]
Germany	0.624	0.706
France	0.056	0.146
Sweden	0.023	0.079
Italy	0.483	0.708
Poland	1.191	1.185
EU-27	0.460	0.578

2.2.4 Life Cycle Assessment

Life Cycle Assessment (LCA) is a structured, comprehensive, scientific based and internationally standardised method (ISO 14040ff) which quantifies all used resources and emissions in an inventory. In a second step the related environmental and health impacts and the depletion of resources which are connected with any products or services are assessed. Life Cycle Assessment takes a product´s full life cycle into account. Starting with the extraction of resources through production, use and recycling, up to the disposal of remaining waste every step of a product´s life cycle is displayed. It also contains upstream and downstream actions remaining to the product, such as depletion or emissions caused during the product´s life cycle (cradle to grave). This idea is also the basis for the LCA emission factors introduced in chapter 2.2.3.

But the main differences between an energy balance, an "only" CO_2 inventory and a LCA study can be demonstrated by looking at one specific energy carrier, oil for example. In the energy balance it is shown in which sector energy from oil is used and how much. Based on this the CO_2 balance calculates the CO_2 (or CO_2-equiv.) emissions of the used oil. In contrast to this a LCA study also considers the impacts of the extraction maybe at the North Sea, the transportation over sea to the refining plants and though the distribution process to the consumption site not only to the greenhouse effect but also to human toxicity, ozone depletion, eutrophication, acidification, summer smog or resource depletion.

LCA Studies help to avoid creating a new environmental problem when solving another. This "shifting of burdens" means you reduce the environmental impact at one point of the life cycle but increase impact at another point trough this activity. This cancel the wanted positive effect of the reduction of impacts.

2.3 Developing a climate policy for a municipality

2.3.1 How to get started

A successful local or regional climate work needs, as mentioned, a few crucial ingredients. One of the most important is of course being aware about the climate change and the importance of doing anything about it. But assuming that this level is already passed (meaning that policymakers and other decision-makers are already positive to being a part of the solution, rather than a part of the problem), the next step is to understand how to start developing a climate strategy or climate policy.

The following questions may therefore be of interest:

- What are the main sources of greenhouse gases in our geographical area? (Energy, transport, industry, agriculture, other)
- Which of these sources do we have possibility to influence? (Should we anyway include sources we have less level of influence on in our strategy?)
- What do we want to focus on in our local/regional climate work? (Selection of sectors and/or selection of gases)
- Which important stakeholders do we need to involve? (Companies, NGOs, citizens, authorities etc)
- How ambitious do we want to be, or can we be? (Follow national or international targets, or better?)

2.3.2 The cyclical management system

The above mentioned questions are all important parts in the making of a baseline review, which is also the first step in a cyclical management system, which can be useful to work with when developing, and carrying out, the climate strategy. A cyclical system means basically that the work with the climate strategy never ends. After having developed and approved a climate strategy, and used it for a while, it needs to be revised. However, the different elements of the cyclical system may not necessarily need to be performed each year, as long as there is some regularity in the cycle.

The main elements of a cyclical system are the following:

- Baseline review
- Target setting
- Political commitment
- Implementation and monitoring
- Evaluation and reporting

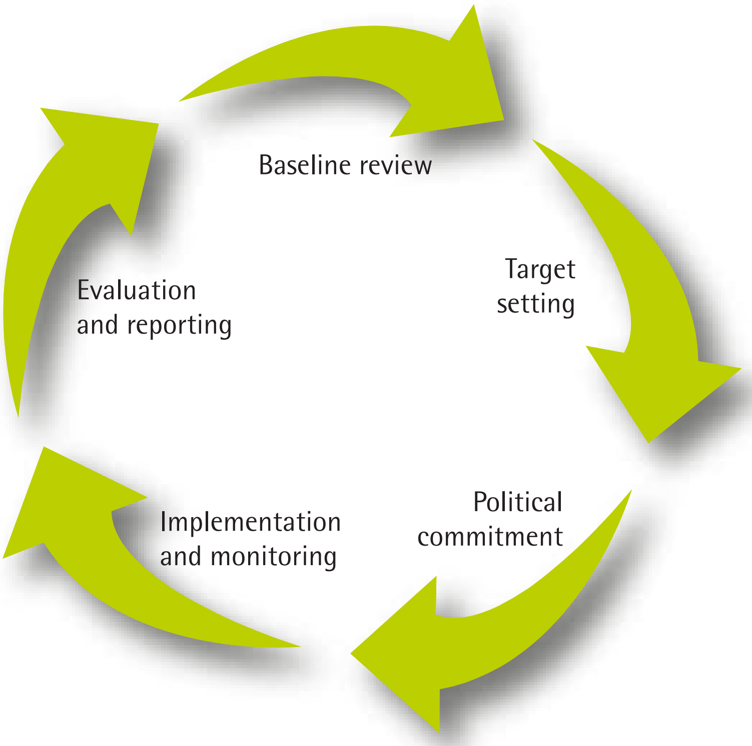


Figure 2.3 The cyclical system can be used in the process for developing a climate strategy.

These elements could in many cases be split into sub-elements, and each element could be treated in various ways. In this report we want to give examples on how this can be done, in order to introduce a successful climate mitigation plan.

2.4 Baseline review

The baseline review is the review of the current status. It is necessary to identify the current state of the art of the municipality or region; otherwise it will be difficult to imagine what is wanted instead, as well as knowing what to focus on for successful climate mitigation. It is necessary to collect as much information as possible in order to make the baseline review as solid as possible.

Important parts of the baseline review are the greenhouse gas inventory, awareness-raising of decision-makers, cooperation with stakeholders, and a brief overview of current policies on different levels.

2.4.1 Current policies

The possibility for local or regional action when it comes to climate mitigation is also depending on other policies on different levels of administration. These policies may be binding or non-binding agreements, legislation, adopted political strategies, political priorities and so on. On international (EU) level, the "20-20-20 targets" adopted by EU, sets the framework for the work with climate mitigation, energy efficiency and renewable energy. A municipality or region dedicated to climate mitigation should at least adopt these targets, but can of course choose to aim much further, once again depending on the local or regional circumstances.

The level of centralisation in a country may also have impact on the possibility of the region or municipality to actually set their own targets and make their own policies, or more specifically – having the possibility to influence the emission sources. For example, in municipalities where the local authorities own the energy production facilities, it is easier to influence the choice of energy sources, than it is if the energy production facility is private or state owned.

National legislation and financial instruments such as CO_2 taxes and investment grants may also play important roles for the success of local and regional climate mitigation – even if it is not under the discretion of the local and regional authorities.

As a part of the baseline review it is also wise to find out if there are any other local or regional steering documents, such as environmental programmes, energy plans, transport plans, comprehensive plans, and what the local and regional political priorities are. These documents may contain valuable information on previous targets, policies, actions that has been developed, as well as processes to learn from.

2.4.2 Awareness-raising

One must assume that when a local or regional authority decides to adopt a climate mitigation plan, the politicians and other decision-makers are already aware of the climate challenge, and maybe also of the benefits of early action. However, it is wise to make sure that all decision-makers stand on the same ground. A successful climate mitigation plan includes a vision or long term targets that last longer than the political election periods, which means that political consensus or binding agreements over a long time are crucial. The arena for local and regional climate work cannot be changed every election period.

Seminars and other education events for decision-makers are good ways to increase the awareness of climate issues. These events could also work as a basis for the development of common visions for the climate plan. In the Swedish City of Växjö, for example, the decision to become a fossil fuel free municipality was preceded with several education opportunities and early involvement of the politicians. The training events were facilitated by the biggest environmental NGO in Sweden, and lots of climate experts were invited speakers. This made all the politicians have the same minimum knowledge of climate change.

2.4.3 Cooperation with stakeholders

A successful climate mitigation plan is also discussed with different stakeholders in the community. It is a fact that the local and regional authorities have limited influence over the greenhouse gas emissions in their geographical area, hence having the understanding and acceptance of the community is worthwhile in order to achieve a strong strategy. It is important to involve stakeholders at an early stage so that they feel that the final product is a result of cooperation. However, it is necessary to first identify what stakeholders to involve and how to involve them. Depending of the structure of the municipality or region, different stakeholders may have different importance. In a rural region, representatives from the agriculture and forestry sectors can be important participants; in urban regions it could be more important to involve industrial representatives. In any case, participants from business associations, universities, citizens, environmental organisations, energy companies etc are important partners. For a municipality, it could also be good to involve the regional level, and/or neighbouring municipalities; and for a region it may be a good idea to involve all local authorities within the region. This is good in order to have a fruitful exchange of ideas, and to understand that what is carried out in one administrative entity, may have consequences on another.

It is recommended to organise a number of meetings, maybe with different themes. During these meetings or seminars (they could be similar to the ones intended for awareness-raising among politicians), it could be interesting to find out about the following:

- What role does the local/regional authority play in the local/regional climate mitigation?
- How do the different stakeholders consider their own contribution to the strategy?
- What challenges and benefits will the community have if there is a major dedication to climate mitigation in the community?
- Is climate an important issue for the different stakeholders, and is it important for people in the elections?

One benefit with involving stakeholders in the beginning and agreeing on a common climate vision is that at a later stage, it could be easier to also involve, for instance private companies, in developing action plans for reduced greenhouse gas emissions.

2.4.4 Greenhouse gas inventories

After having decided on a vision or long term targets together with stakeholders, it is time to really find out the current status. What kind of emissions do we have today, and from what sectors? Is it carbon dioxide due to energy production or transports, or methane or nitrous oxide from agriculture or landfills? Therefore, a greenhouse gas inventory is the next step to take. This is preferably combined with an energy inventory, which makes it easier to define potentials of transition to an energy smart community where the energy comes from renewable energy sources, and is used efficiently. However, what many municipalities and regions experience is that such an inventory can be hard to work through, not at least because the availability of necessary statistics may be scarce.

Here is a guide describing different parts of a greenhouse gas inventory, which is combined with an energy balance. This means that other greenhouse gases than CO_2, are not really covered by this. However, similar research may be needed for those gases.

2.4.4.1 How to start?

A greenhouse gas inventory is preferably done before the climate target is decided upon. The reason for this is that after an inventory is done, it is easier to define a target, since there is more information available. However, it is possible for a regional or local authority to adopt progressive climate targets anyway, and then afterwards make an inventory and a plan for what actions that are needed to be done in order for the target to be achieved.

There are a few fundamental parts to consider when introducing a greenhouse gas inventory:

- Is the inventory covering the geographical area of the region or municipality (recommended), or only the administration and its work?
- Should the inventory also include a full energy balance (recommended)?
- How to define boundaries and calculation methods for emissions from transports?
- What greenhouse gases should be included?
- How ambitious and detailed should the inventory be?
- What about climate impact from our consumption?
- How frequent should the follow-up be?

2.4.4.2 Borders

The first thing to do is to define the borders of the inventory. The inventory should cover the same thing as the climate target is covering, which basically means that if the climate target is covering the geographical area, then the inventory must do so too. If the target is covering the administration of the city or region, the inventory should cover it. Here we are mainly focusing on regions and cities, therefore a geographical area approach is followed. Targets and inventories for administrations are more connected to internal environmental management systems. A geographical approach means that the inventory, and target, is also taking into consideration activities carried out by citizens, companies and industries - many activities that the regional or local authority itself cannot control.

2.4.4.3 Greenhouse gases

The second thing to do is to decide what greenhouse gases to include in the inventory. The commitments in the Kyoto protocol cover six greenhouse gases (CO_2, CH_4, N_2O, HFC, PFC and SF_6). Depending of the local and regional circumstances, the different gases have different level of importance for the regional or local contribution to climate change. However, the "industrial gases" (HFC, PFC and SF_6), are in most cases relatively small share of the total emissions, which makes it worthwhile to focus on the other three. And even if you choose in your climate strategy to focus on CO_2 only, it is still wise to be aware that the other gases exist and may play an important role, and also that while the actions to reduce CO_2 emissions are carried out, the other gases will take a larger share of the total emissions.

In most places, the production/use of energy and transports are the main sources for the CO_2 emissions. The emissions are of course split on different sectors (public, private, industrial, agricultural etc). In some places, non-energy related activities can also be main sources of CO_2, such as production of concrete. Landfills and agriculture contribute with major amounts of CH_4 and N_2O.

2.4.4.4 Ambition level

Another important thing is to decide upon the level of ambition, which can somewhat be connected to the availability of statistics. Collecting the necessary statistics in detail may be a hard and time consuming work, especially if it has never been done before. In some cases statistics will be available, in other estimations is better than no information at all. The important thing is to understand what estimations have been done, and why. Since inventories are likely to be carried out regularly in order to be able to follow the development, it is always possible to revise the figures when more exact information is available.

2.4.4.5 Energy balance as a basis for the inventory

A greenhouse gas inventory focusing on CO_2 means that it is necessary to find out all the use of fossil energy used in the area, and then multiply it with the respective emission factor. However, at the same time as a CO_2 inventory is done, it is recommended to also create a full energy inventory, also taking non-fossil fuels into consideration. This approach makes it possible to also gather enough statistical information for the creation or follow-up of other targets related to for instance energy efficiency. It will also give important information to understanding the potential of actions to be carried out, and it gives a picture of the total dependency on fossil fuels.

The energy balance is structured so that it shows both the energy supply and the energy use, and everything that is happening in between. In the following pages we will describe what to think of when collecting the necessary information to the inventory. There are different software tools that are especially designed to be used for energy inventories, but you can simply use Excel or corresponding software. In any case, no matter what software you choose, you will still have to collect the information yourself.

2.4.4.6 Collecting statistics

When all the above has been reflected it is time to start collecting statistics. One recommendation is to create a table where all the energy sources are included. Then it is recommended to structure each energy source at a more detailed level. For instance, under the energy source "oil", there could be separate entries for oil used in energy plants, oil used by households, oil used in industry etc. This will make it easier to follow and, if necessary, revise in the future.

Depending on the level of ambition, the number of energy sources to be included may vary. Below is a list of energy sources that are likely to be included (however, several more may be involved, and some of the sources may be used for other purposes than mentioned below):

Fossil fuels for energy purposes

- Oil
- Coal
- Natural gas
- Peat
- LPG

Fossil fuels for transport purposes

- Diesel
- Gasoline
- LPG
- CNG
- Jet fuel (if you have chosen to include air transport)

Other non-renewable energy sources

- Waste (partly renewable, partly non-renewable)
- Nuclear

Renewable energy sources for energy purposes

- Hydro
- Wind
- Solar thermal
- Photovoltaic
- Wood and other biomass
- Geothermal
- Biologic oils

Renewable energy sources for transport purposes

- Ethanol
- Biogas, biomethane
- Biodiesel

It is recommended to start investigating what information is available at local/regional level, before searching for other statistics. In some countries, there are national agencies trying to break down the national energy and climate statistics on regional and local level. However, it may contain errors that can have big impact on the local statistics. You may decide that during the first inventories this information is good enough anyway. Also, be aware that in some cases, information about some energy sources may be classified, and therefore difficult to find out about. It could be wise to stress for the companies/agencies that your interest in the statistical information is in order to make an energy balance or climate policy – not to reveal any potentially classified information.

Energy plants

It is very likely that you have one or several energy plants in your area. They may be used for the production of heat, electricity, cooling, vehicle fuel, or a combination of several of them. They may be public or private owned, and they may use one or more energy sources. They may be large scale, such as big hydro power plants, or small scale, such as a district heating plant in a small village.

Contact the energy companies and see if you can retrieve the information about supplied energy from different energy sources, as well as produced energy for different purposes. If they also can give a description of to what kind of customers they sell their energy, it will also be a great source of knowledge for you, since it can for instance help you understand if their heat customers are mainly households or industries.

If it is not possible to get the information from the energy companies, you have to try to make an estimation based on, for instance, the number of households. Combine these with any available statistics on average use of heat, electricity and gas per household in your country or region. This may be a good enough level to start with, depending on your ambition level.

If there are really big electricity production facilities, that actually are more of a national plant, then it is recommend that you define how to treat the electricity produced there. One way is to assume that the electricity used locally is also produced in this plant, or you consider that you are using a national electricity mix instead. Plants that produce heat are mostly delivering it to the same municipality where they are located.

Small scale energy production

In most municipalities and regions, a substantial part of the energy used for heating and electricity are produced in smaller entities. Examples are the use of oil, wood, heat pumps and solar energy for heating in households, as well as PV plants and small scale hydro power plants. Statistical information about the energy use in these buildings may be very difficult to find, so very often some kind of estimation will have to be made. In some countries, there are inventories carried out now and then on national level, which can be a source of knowledge also for you. Chimney sweepers can also provide information on the number of buildings using oil or biomass for heating purposes.

If you are mostly interested in a CO_2 inventory, and not a full energy balance, most of these energy sources are not that interesting – except the use of oil, and perhaps gas.

Transport

Fossil energy sources are the most common in the transport sector, meaning that transport stands for a substantial part of the CO_2 emissions in a municipality or a region. The transport sector includes road traffic, but could also include air traffic, ship traffic and vehicles used in agriculture, forestry, industry and technical management. Before drawing up an energy balance or CO_2 inventory it is very important to set the boundaries for the transport sector. The reason for this is that energy used in households, industries, street lights or public localities is connected to objects that are standing still within the geographical area; instead vehicles are moving inside and outside the area. While defining these boundaries, it is also important to consider what information is excluded due to this. Here are three examples.

a. Fuel based

In this method, you consider how much fuel that has been fuelled within the borders of your municipality or region. The fuel could be fuelled at fuel stations, but don't forget that transport companies, industries and agriculture may purchase their own fuels separately. Contact the fuel companies and ask them how much fuel (gasoline, diesel, bio-fuels) they sold during the year you have chosen as base year. If you cannot get the information from the companies, another possibility is to check if there is any statistics on local/regional fuel use compiled by any national agency. The advantage of this method is that it will be based on an absolute amount of fuel – a statistical source that you will be able to have access to every time you make the inventory, and you don't need to do estimations. The disadvantage of this method is that you cannot of course know how much of the fuel sold in your area is also used there. Especially, this is a problem for any geographical entity along important high-ways, which means that the difference between vehicles from your area fuelling in other areas and vehicles from other areas fuelling in your area tends to be big. A similar situation arise if there is a big harbour or airport in the areas, and it is therefore necessary to also decide whether to include it or not – at least whether to include it or not in the climate targets.

b. Traffic based

In this method, you consider how much traffic there is on the roads in area. In order to retrieve the information here, you need to count the traffic-load on the different roads in the municipality or region. This is most probably being done, but maybe not regularly, and maybe not in all the roads and streets.

However, based on the available information, it is possible to make assumptions on the total traffic-load, and maybe also get a relative split on cars, buses, trucks etc. The advantage with this method is that your CO_2 inventory will be more connected to what is happening within your geographical borders, no matter where the vehicles are fuelled. The disadvantage of this method is that you will not get any information at all about the split between different kinds of fuels. Instead you will have to rely on that the vehicles travelling within your area follows the national average split between fuels and energy efficiency. If your area is well-known for its infrastructure of bio-fuels, which increases the probability of a higher share of vehicles using bio-fuels, this will not be seen in the statistics.

c. Registration based

Another method is to focus on all the vehicles registered within your area, if such registration is done and information available. This will probably mean that you can get a list on how many vehicles that are using different fuels, what kind of vehicles they are etc. Based on estimated average travel distance per year, and estimated average fuel consumption per km, it is also possible to come up with a total fuel amount. The advantage of this method is that you will include only the vehicles that are "belonging" to your area, and you will include all their fuel no matter where it is fuelled. The disadvantage is that you have no local reference information at all. You must base a lot on estimations, and the slightest difference from reality will have big effects when the total amounts are being calculated.

2.4.4.7 Advanced

The above described is only referring to the CO_2 emissions related to fossil fuels used within a certain area, or by the people living in that area. But as mentioned previously it is possible to go even deeper in the ambition to create a greenhouse gas inventory. Non-energy related CO_2 and other greenhouse gases could be included in a similar way, after an inventory is done. If you want to be really advanced in your work, then you can also start to analyse the consequences of the lifestyle of the population. What are the consumption patterns? The actual greenhouse gas emissions that a community is causing, is actually not only from everything that is happening within the borders. The more accurate reality is to include all the emissions cause by everything that has been imported to the area, minus the emission from everything that has been exported from the area. This is of course very difficult to find out information about, and the approach must be very general, if included.

2.4.5 Analysis of on-going activities

When all the statistics is collected and displayed in a way so it is easy to understand, and before going on to the next step in the management cycle, it is recommended to analyse if there are any activities going on in the municipality or region that will have major impact on the greenhouse gas emissions, or in other words, that will change your CO_2 inventory to a large extent. Knowledge about activities that increase or decrease the emissions in the near future is necessary in order to give the target setting credibility. On-going activities that may cause major changes in the emissions could for example be the building of a new power plant, change of fuel in an existing power plant, the establishment of an energy consuming industry, or a rapid increase of population (which may have a big impact if your municipality is small).

Box 2.1 – Example of the French regional inventory

For ten years, the associations for air quality monitoring in the region Rhone-Alpes have been developing a register of emissions. This tool highlights the most pollutant sectors allowing to build an environmental diagnostic of territories. The diagnostic can be done to analyse the current situation, but also to evaluate the future implementation and impacts of policies on pollutants emissions.

There are several uses of the register as:

- input data source for regional modelling;
- a contribution to the regulation to characterise air quality of the territory;
- a tool for decision support, through the implementation or actualisation of planning documents (identification of field emission reduction, assistance to local authorities in strategic choices to improve air quality);
- a contribution for climate change mitigation, helping local stakeholders in their choices.

The register of emissions is considerate as "a qualitative and quantitative description of pollutants discharges in atmosphere from natural and/or anthropogenic sources".

The elaboration of an emissions register consists of theoretical computations of pollutant flows emitted in atmosphere. It is implemented crossing primary data (statistics, traffic counts, surveys, energy consumption etc.) and emission factors.

Several categories of sources of atmospheric discharges are considered by the inventory method.

However, these categories may or may not exist, according to circumstances:

- point sources: a point source usually means a stationary plant such as a factory;
- linear sources: these essentially consist of major transport lines (roads, rivers, sea routes, etc.). So they usually derive from moving sources, or occasionally fixed sources such as gas or oil pipelines;
- area sources: this category covers the remaining sources consisting of stationary sources not included in the category of large point sources, together with the stationary and mobiles sources not included among the large linear sources. Here are typically low-level urban traffic, residential areas, cultivated land, etc.

The different steps to carry out the inventory are the following:

- identification, for each pollutant, of the sources on the territory and for a period of time considered;
- determination of emission for each source;
- aggregation of all sources identified;
- validation of results.

In Rhône-Alpes, the emission inventory is available on the whole territory, for each year between 2000 and 2009 for greenhouses gases (carbon dioxide, methane, nitrous oxide) and substances linked to acidification, eutrophication, photochemical pollution, suspended particles (PM_{10} and $PM_{2.5}$), polycyclic aromatic hydrocarbons, heavy metals, dioxins and furans.

2.5 Target setting

Now when you have all the information and data it is time to start the target setting. As mentioned earlier, it is possible to have different levels of ambition also in target setting. The target setting procedure is quite concrete and should ideally cover short-term and long-term targets and define indicators. It is also necessary to be clear with what is included and what is excluded. It is a good idea to also include different stakeholders in this process, especially if they haven't been involved earlier.

2.5.1 Boundaries

Based upon the information you have retrieved in your inventory, and based upon the circumstances in your area, you can define what sources of emissions are to be included and not. Does the target only include CO_2, or all the greenhouse gases? How do you treat possible facilities of national character in your area (such as harbours, airports, power plants and big industries), since you probably have less influence over their emissions? For example, a big industry in a city uses lots of coal in its processes, and stands for 90% of all the local emissions. If these emissions are included in the target, all mitigation actions carried out in other areas will have very little impact on total emissions. In that case it may be smarter to set a target saying that you shall reduce the CO_2 emissions by 50%, excluding this industry.

2.5.2 Indicators

You also need to identify a number of indicators that can be used to follow your progress, but also one or two that will be the main indicator for the mitigation target. The most common are probably the total amount of CO_2 (or CO_2e) and CO_2 (CO_2e) per inhabitant (i.e. per capita). On international level, when setting reduction targets for countries, it is the total emission indicator that is used; hence no consideration is taken to possible increase due to population growth. Using the per capita indicator means that your target is not depending on population changes.

Greenhouse gas indicators can be combined with other indicators, reflecting energy use, installed renewable electricity, relations between greenhouse gases and economic growth etc. Targets can be developed for all of these, but the more targets you set, the more you have to make sure that they are not contradictory.

2.5.3 Targets

The most important thing when it comes to the targets is to make them very clear, understandable, and measurable. They should also have a date when a certain level should be reached, or a reduction achieved. The date should however not be too far away; in that case it is better to also set medium or short term targets. Otherwise, there is a risk that the target is not taken seriously or becomes alive only when you start reaching the end date.

Probably the most common targets are structured like this:

- CO_2 emissions shall be reduced by 50% between 2000 and 2020
- CO_2 emissions per inhabitant shall be reduced by 50% between 2000 and 2020.

But they could also be structured like this:

- CO_2 emissions shall be less than 200,000 tons by year 2020
- CO_2 emissions per inhabitant shall be less than 3 tons by year 2020.

And as mentioned previously, it could be smart to also specify what is the target geographical area, if it is CO_2 only or all greenhouse gases (CO_2e), and if something is excluded in the target. It is also possible to split the targets per sector, for instance a reduction of 70% in the households, 20% in industry and 10% in transport.

2.5.4 Climate mitigation plan

When the targets have been identified, it is important to put them into their context and identify actions to be carried out in order to reach the targets. The actions can be carried out by the local or regional authorities, but the actions carried out by different stakeholders are also important and should ideally be included if possible. Therefore, the dialogue with stakeholders is important throughout the whole process. Of course, the process could be different: policy makers can decide upon the targets first, and then ask for them to be included in a climate mitigation plan.

It is not necessary that you fill the mitigation plan with all the actions needed to reach the targets, especially not the long term targets. It is more important to include actions that will make you reach your short term targets.

It can be recommended to also make a prognosis of how the actions will impact the CO_2 emissions. In this prognosis or scenario you should also include effects of national instruments, such as taxes, and technical developments which leading to a more efficient use of energy. Since the targets are probably valid for a longer time period than the actions mentioned in the plan, it is also necessary to include information on how often the plan is going to be revised.

Another part of the mitigation plan, that may be important depending on the local/regional conditions, is to analyse what other effects the plan will have if the actions are carried out. Will there be positive or negative effects on air quality, bio-diversity, water quality, business sector and economy?

2.6 Political commitment

In order for the targets to come into force, they need political approval and commitment. As mentioned earlier, the targets and the mitigation plan could either be approved separately or jointly. This step is extremely important in order to create a solid link between targets and actions, but it also makes it easier to incorporate the costs of the actions in the coming budget allocations. The political commitment runs more smoothly if the politicians are involved from the beginning of the mitigation process.

You should also not neglect the importance of decision-makers becoming proud of their newly adopted climate plan and climate targets. Arrange press conferences, events or seminars so that you can share these decisions with the public opinion. If your municipality or region becomes known for its mitigation ambitions, you could benefit from it.

2.7 Implementation and monitoring

After the political approval it is time to start implementing the plan, and make sure that things are actually happening. The plan should have identified responsibilities and time schedules for different actions, so it should be quite easy to monitor the progress. In some cases, the actions will be carried out easily, in other cases there may be a long process to receive funding and make technical design.

Some actions may also need specific political decisions on financing, which can take some time. It is quite important for politicians to be able to show others that their decisions are successful. Therefore it is recommended to start focusing on the "low-hanging fruits" – the actions that are quite easy and cheap to carry out, but will cause enough reduction of climate gases to make a difference in the follow-up.

The monitoring of the actions can be compiled in a report that is presented to the politicians and to the stakeholders, so that they can see that the actions are on track. Such a report should be compiled regularly, maybe once per year.

2.8 Evaluation and reporting

This step is very similar to the previous one, and is necessarily not needed every year, at least not if the reporting is solved through a monitoring report as mentioned above. This step is very important when coming closer to the time for revision of the climate plan. While the monitoring step is mostly about identifying whether the actions are carried out or not, the evaluation is more important in order to understand if the action achieved its expected results. Did the greenhouse gas emission decrease, and was the decrease larger or smaller than expected? How much did it cost? Were there any problems met, and how were they solved?

After evaluating all the actions you will end up with a total amount of greenhouse gas reduction due to the mitigation plan. However, and this is important, this does not mean that the emissions in your geographical area are reduced of the same amount. It is more likely that activities going on outside your mitigation plan has also caused changes – which could for instance be linked to national financial instruments and peoples' behaviour. The only way to get a full picture of how far you have come towards your target is to make yet another greenhouse gas inventory. Depending on how much personnel resources and time you have, you must consider how often you need such an inventory – it is not necessary to make them every year, but they should at least be done every time the mitigation plan is being revised.

Another important thing about the evaluation is that you will retrieve information that can be necessary for new priorities and introduction of new actions.

An environmental management system can be used in order to make a follow-up of the indicators and the progress should also be presented to the public, for example through official web pages.

2.8.1 Next cycle

This concludes the first cycle of the climate mitigation plan and its follow-up. But as mentioned, a cyclic system means that you are now back where you started. In fact, the monitoring and evaluation sections are similar to the work carried out in the baseline review, not at least when it comes to the greenhouse gas inventory. Even if the cycle now starts again, it does not mean that you have to do everything again, or that you have to do the full cycle every year. For instance, the target setting is not likely to be necessary until you are coming closer to the year when your target should be reached. The political commitment is probably not needed until you have revised the mitigation plan, etc.

2.9 Greenhouse gas budgeting

Budgeting of greenhouse gas emissions can actually be the same thing as setting detailed targets. This could be done for a geographical entity, but is maybe even more appropriate when it comes to the emissions of a public authority. Greenhouse gas budgeting could be a successful way to steer towards the climate targets of, for instance, the city administration, and is therefore an important part of the local environmental management system.

2.9.1 ecoBudget

The idea of an environmental management system for politically steered organisation, using the terminology of the financial world, but dealing with the environmental world, was initially proposed by the association ICLEI - Local Governments for Sustainability (www.iclei.org). ICLEI thought that if it is possible to have a budget system for financial resources it should also be possible to have a budget system for environmental resources. The financial terminology is familiar among the decision makers, so by using "ecological budgets" and "ecological accounts", it should be easier to make environmental aspects more accessible and understandable. This is the basis of the environmental management system ecoBudget (www.ecobudget.org), which has been tried in several municipalities in the world.

EcoBudget is a very flexible system, and you can base it on the environmental resources that are important for your area. However, in this report, we will focus on how it can be used for the steering towards a reduction of greenhouse gases.

2.9.1.1 Climate budget

The cyclic management system is also used in ecoBudget, so it will not be introduced further here. We assume that there is a climate target for either the geographical area, or the public administration (or both), but here we aim at the climate target for the administration as an example. Let's assume that you have decided that the CO_2 emissions from your administration shall be reduced from 5,000 tons in year 2010 to 1,000 tons in year 2020. This long term target within the ecoBudget would be described as CO_2 budget of year 2020 is 1,000 tons.

If your administration has several departments (technical department, planning department, etc), the budget of year 2020 could be split on the different departments in order to get a detailed view of each department's responsibility, see example in Table 2.6.

Then, since year 2020 is so far away, it is important to break it down to annual targets, or annual CO_2 budgets. When setting these annual budgets, you can take different circumstances into consideration. The budget will help making the emissions more concrete, and show that you must do things every year in order to reach the budget of year 2020. The short term CO_2 budget (and other environmental budgets) is ideally presented to the decision-makers at the same time as the financial budget (see Table 2.7).

Table 2.6 Example of a climate budget

Department	CO_2 2010 (tons)	Budget 2020 (tons)	Reduction
Dep A	2,400	400	-80%
Dep B	900	120	-87%
Dep C	500	80	-84%
Dep D	1,200	400	-67%
Total	5,000	1,000	-80%

Table 2.7 Breakdown of a climate budget

Department	CO_2 2010 (tons)	Budget 2011 (tons)	Reduction
Dep A	2,400	2,300	-4%
Dep B	900	875	-3%
Dep C	500	475	-5%
Dep D	1,200	1,200	-4%
Total	5,000	4,800	-4%

Now, every department knows that during the following year they need to reduce their emissions, since their CO_2 budget is lower than the base year. They may need to compile action plans describing how they should reach that level.

2.9.1.2 Climate account

When a year has passed, and it is time to compile the financial accounts, it is also recommended to compile the ecological accounts, which means that you collect the environmental results and present them. The actual emissions of the year is compared to the budget every department had, which makes it easy to see if you have managed to stay within your ecological budget frame, or if the budget has been exceeded – meaning that you have emitted more CO_2 than the budget allows. The result is then used in order to create a budget for the next year, and so on.

This is a good way to steer towards reduced emissions and make sure that the targets are reached. The same system can be used for the emissions in the geographical area, in order to make sure that you are on track towards the mitigation target. It will then also play a key role in the monitoring and evaluation reports presented to the politicians.

2.10 Examples from French regional law

2.10.1 A Climate and Energy Territorial Plan (CETP)

A Climate & Energy Territorial Plan (CETP) is a voluntary step directed from the stakes of climate and energy with ambitions marked and shared by the key players of the territory to globally reduce GHG emissions and to adapt the same territory to the consequences of climate changes.

A CETP lays down the objectives of the territory and defines an action plan to reach them. It gathers all the measures undertaken in order to reduce the GHG emissions in all the fields of the economy and the everyday life of the population.

Since July 2010 and the passing of the Grenelle 2 Law, all French administrative divisions with a population of more than 50,000 must introduce a Local Climate-Energy Plan.

Main elements characterising the Climate & Energy Territorial Plan

A CETP is essentially characterised by:

- the objectives it should achieve,
- the scope of actions that includes,
- the actors engaged on the territory.

The objectives

First, a CETP is characterised by ambitions encrypted reduction of GHG emissions and adaptation planning in the time constraints.

A CETP sits on the ambitions and deadlines established by international negotiations and national plans, with three deadlines:

- 2012, one of obligations under the Kyoto Protocol,
- 2020, the term of the next commitment period ("post-Kyoto"),
- 2050, that of a division by 4 of French emissions.

For 2020

- A strategic long-range temporal commitment

The development of a CETP is a particular event in the political territory. Indeed, there is no precedent for regulatory obligation, whose implementation is addressed to all actors in a territory that stretches over a time horizon of about half a century.

- For the goals of European commitments

The CETP should adopt the European objectives of "3 times 20" by 2020. These objectives are:

- 20% reduction in GHG emissions,
- 20% improvement in energy efficiency,
- a 20% share of renewables in final energy consumption.

For 2050, in France: Factor 4

- Actions to be taken quickly and deploy gradually

Quantified targets should be determined accurately and methodically for long-term and actions size accordingly. If 2050 seems to be distant, relating to progress in some sectors, implies to initiate an effort high and consistent today. This is, for example, heating rehabilitation of the entire built heritage or the extension and intensification of public transport at the metropolitan scale.

- A prospective approach to adopt long-term goals

he deadlines of 2020 and 2050 allow to consider major changes in structure and breaks in behaviours and technologies. The prospective group that begins CETP will emerge with a vision of the area and a long-term trajectory for achieving this vision.

Stages of setting up a Climate-Energy Territorial Plan

The establishment of a CETP is implemented through several phases.

1 – Prefigure

To prepare the adoption of a resolution of commitment, the community will have to take the following first steps:

- ownership of the subject by elected officials and services,
- clarification for all players in the perimeter of CETP, the choice of its internal organisation,
- identifying the fullness of the work according to the characteristics of the territory,
- the implementation of a specification; it will both organise the staff working in the community and frame the possible assistance of a project management.

2 – Diagnose and mobilise

To identify possible courses of action and facilitate the movement of local actors, this second stage will include:

- achieving a climate profile of the territory comprising both the register of GHG emissions, identification of impacts and the assessment of regional vulnerabilities to climate change;
- actions of awareness and training of actors;
- the commitment on cuts immediately possible to reduce emissions;
- active research for effective actions, through the establishment of a participatory process.

3 – Building the CETP

Actions will be defined, analyzed and selected for a decision by the elected assembly. This requires an appraisal of projects about the technical, financial, legal, organisational and partnership aspects. This will include:

- the definition of a strategic framework that will set clear objectives and engaging;
- to prepare the program of action involving both on the competences of the community and on actions on the whole territory; it forms the core of CETP.

The strategic framework and action program will be a deliberative framework that expresses the political will community and which engage regarding national and regional objectives.

4 – The implementation

This phase will consist of the operational implementation of decisions taken in the previous phases.

2.10.2 Regional Plan Climate Air Energy (SRCAE)

The building of the SRCAE (Schéma Régional Climat Air Énergie - Climate Air Energy Regional Plan) of the region **Rhône-Alpes** was officially launched on December 6th 2010 by the prefect and the regional president. This plan should be implemented end of 2012.

The SRCAE will be a strategic and unique document which integrates all the dimensions of climate, air and energy by defining orientations on the air quality, the reduction of atmospheric pollutants, reduction of greenhouse gas emissions, control of the energy demand, improvement of the energy efficiency, development of all sectors of renewable energies, and adaptation to the effects of climate change. SRCAE gives orientations for local policies in order to reach European objectives "3 times 20" in 2020 and French objective "Factor 4" in 2050.

When SRCAE is implemented, all plans dealing with energy, air quality or climate implemented at a local administrative division of region Rhône-Alpes should be compatible with the orientations given by the SRCAE.

Working groups have been constituted with representatives from French State, Local authorities, Employees, Companies, civil society (environmental NGOs, etc.).

In Rhône-Alpes a sector-based approach for workshops will be taken, with three workshops on transport and town planning, building, housing and tertiary and industry, farming, forestry.

These workshops are completed by two thematic workshops about adaptation to climate changes and energetic production.

Box 2.2 – LAKS procedures and tools

LAKS
Local Accountability for Kyoto goalS

READY TO USE TOOLS AND PROCEDURE FOR MUNICIPALITY CLIMATE PLANNING

A recently completed EU Life+ project led by the Reggio Emilia municipality (Italy) produced a 4-step procedure and the needed tools (Excel and Word files) to carry it out. The complete description of the process is available (in English, Italian, Spanish and Polish) here:

http://space.comune.re.it/laks/web/index.html

STEP 1. GHG Emission Inventory

This step aims at developing a local inventory of the main GHG emissions generated at local level taking into account the most relevant sectors (energy production, public buildings, public lighting, residential and industrial sector etc.). This represents the baseline on which the Mitigation and Adaptation plan will be based to define municipality's emission reduction target.

STEP 2. Multi-criteria Policy Assessment

The multi-criteria policy assessment has been developed in order to identify the most suitable interventions to be included in the Mitigation and Adaptation plan, it aims at:

- evaluating the local environmental, social and economic impacts linked with the implementation of policies and interventions to be included in the Mitigation and Adaptation Plan;
- helping authorities to select the best option interventions;
- driving the path from the inventory to the plan by helping municipalities in thinking about different possible options by taking into account environmental, social and economic impacts;
- creating a useful database of possible policies to reduce CO_2 emissions at local level.

STEP 3. Mitigation and Adaptation Plan

This step aims at developing the Mitigation and Adaptation Plan by:

- developing a plan that includes all interventions that can reduce GHG emissions at municipal level;
- involving municipality's different sectors in understanding what they can do to reduce GHG emissions at local level;
- setting targets and specific responsibilities to make easier monitoring results.

STEP 4. Climate Balance

The Climate Balance is the monitoring system developed by the LAKS project is order to yearly evaluate the state of implementation of policies included in the Mitigation and Adaptation Plan and consequent results obtained. You can compile the Climate Balance every year in order to make it a continuous accountability process and integrate the Mitigation and Adaptation Plan in the decision making process of your municipality.

MAIN STEP	TOOL	GUIDE
STEP 1. GHG Emission inventory	LAKS GHG Inventory tool *Excel file* GHG Emission Report *Word file*	Local Government Greenhouse Gas Emissions Inventory Guide
STEP 2. Multi-criteria policy assessment	Multi-criteria policy assessment *Excel file* Multi-criteria policy assessment report *Word file*	Guide for developing the multi criteria policy assessment
STEP 3. Mitigation and Adaptation Plan	Mitigation and Adaptation Plan draft tool *Word file* Methodologies for calculating CO_2 reductions Mitigation and Adaptation template *Excel file*	Guide for developing the Mitigation and Adaptation Plant
STEP 4. Climate Balance	Climate balance template *Word file* Updated GHG Emission Report *Word file*	Guide for developing the climate balance

Chapter 3

Adaptation planning

3.1 Basic elements

Whatever we do for climate change mitigation (chapter 2) the climate system will take a long time to react and the influence of past human activities will be visible for many decades and will have an influence on cities, on the countryside and the natural environment. Adaptation to climate change is therefore essential to cope rationally with these issues, in order to minimise impacts and costs.

Climate adaptation can then be defined as a rational and planned change in environmental, social and economic systems as a result of current or expected climate change. Climate adaptation for example produces changes in processes, methods and structures, either in order to mitigate negative impacts or to exploit new opportunities arising from climate change.

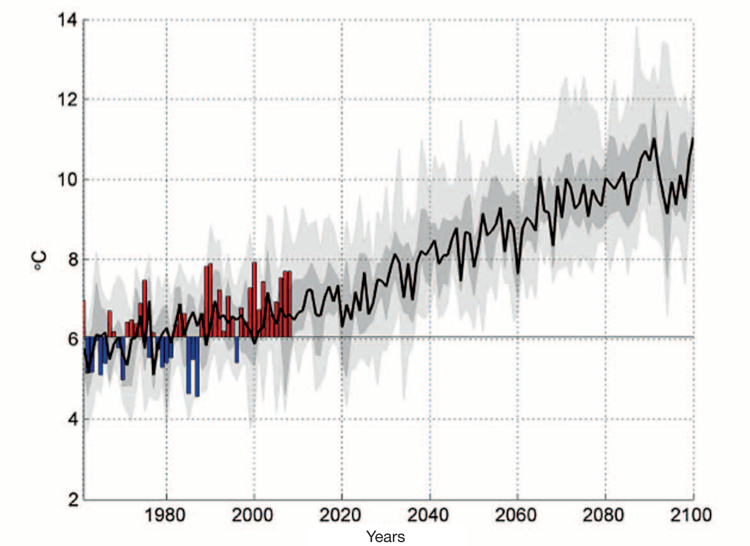


Figure 3.1 Example of regional (county of Kronoberg, Sweden) projection showing annual mean temperature simulation based on 16 different climate scenarios. Blue and red bars shows observed mean annual temperatures. *(Source: SMHI)*

Adaptation covers a wide number of activities and actors in areas such as urban planning, civil protection, contingency planning, water supply, health, agriculture, environment, and technical infrastructures. Operators on both regional and national level, from sector agencies to NGOs, industry, various municipal departments and individuals, are concerned with the issue of climate adaptation planning.

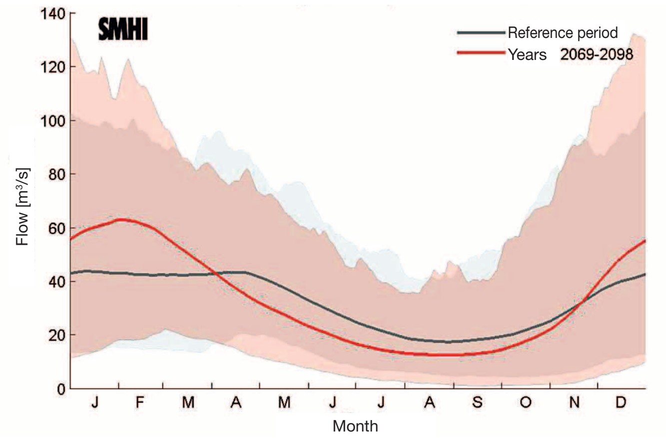


Figure 3.2 Example of chart showing expected changes in average flow in Mörrumsån river, Sweden. *(Source: SMHI, reference period 1963-1992)*

When initiating the climate adaptation process at the local/regional level, it is important to start with *appropriate climate change information for regional/local conditions*. The national weather service, or similar institutes, can be a source of information when it comes to providing climate simulations and projections. These projections will provide the basis of climate adaptation planning (Figures 3.1-3).

For example basic scientific information about climate adaptation in Sweden can be found at the national platform for climate adaptation: www.klimatanpassning.se (in Swedish).

For a survey of information available throughout Europe refer to the European Environment Agency site called European Climate Adaptation Platform (CLIMATE-ADAPT) (see box Essential tools).

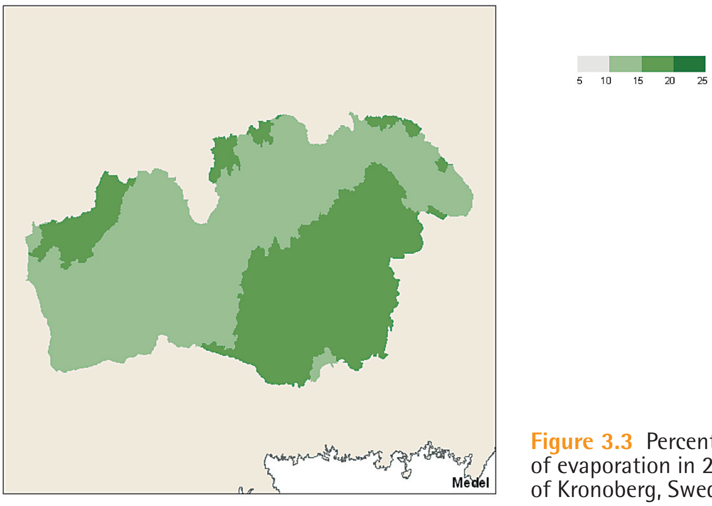


Figure 3.3 Percentage change of evaporation in 2050, in the county of Kronoberg, Sweden. *(Source: SMHI)*

Box 3.1 – ESSENTIAL TOOLS

CLIMATE-ADAPT European Climate Adaptation Platform (new!)

http://climate-adapt.eea.europa.eu/

The CLIMATE-ADAPT site aims at supporting Europe in adapting to climate change. It is an initiative of the European Commission and helps users to access and share information on:

- Expected climate change in Europe
- Current and future vulnerability of regions and sectors
- National and transnational adaptation strategies
- Adaptation case studies and potential adaptation options
- Tools that support adaptation planning

GreenClimeAdapt:

http://www.malmo.se/greenclimeadapt

GreenClimeAdapt demonstrates how cities can address climate change with green solutions. The project shows how to respond to increased precipitation and heat waves through green tools such as open storm water management, green facades and green roofs.

Tools for climate adaptation (in Swedish):

http://www.smhi.se/klimatanpassningsportalen/verktyg

This site gives suggestions for how to develop and establish a climate adaptation plan for a municipality or county. There are also links to different climate research programs developing tools for adaptation work.

3.2 Climatic adaptation planning procedure

This chapter describes one possible process to facilitate the climate adaptation planning for regions and local authorities. Adaptation actions are needed to protect people, buildings, infrastructure, businesses and ecosystems. Due to the varying severity and nature of climate impacts between regions in Europe, most adaptation initiatives will be taken at national, regional or local level. The ability to cope and adapt also varies across populations, economic sectors and regions within Europe.

There is a need to assess *how* climate change will affect the society, *what* the consequences will be, *what* measures will be appropriate, *when* they need to be carried out, *what* the costs will be and *who* is responsible. To keep this together, a well working process is needed.

The first part of this chapter describes how to make an *impact and vulnerability assessment*, in order to identify positive and negative impacts of climate change in various systems of society, both technical and agricultural systems as well as natural environment and impact on humans.

The second part of this subchapter focuses on how to assess the ways in which the *consequences* can be addressed, and the *costs* involved, as well as to clarify *responsibilities*. All is framed by a process that holds the assessments together (Figure 3.4). In this work, you should consider all available, relevant material that may have bearing on climate adaptation, such as elements of risk- and vulnerability analyses, other risk assessments or environmental work. Some of the results from the assessment of climate change will in turn be useful in other processes.

Apart from an impact and vulnerability assessment and a measures and cost assessment, the climate planning process needs to be *updated* on a regular basis. Monitoring and evaluation of measures are also input values to improve the climate adaptation planning. The development of both knowledge about the climate change, as well as the technology and socio-economic development, must also be considered since they are important for adaptation planning.

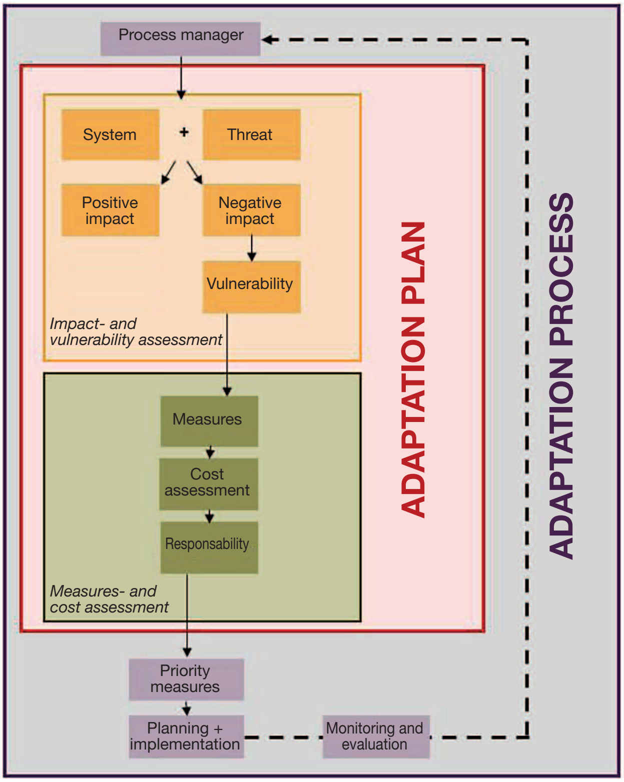


Figure 3.4 Climate adaptation process and plan

Also, one must have in mind to highlight areas where *adaptation* actions also can have a *mitigation* effect.

For example green roofs and green walls in buildings in an urban environment can have both an adaptation effect as well as a mitigation effect. As an adaptation measure, a green roof/wall has a cooling effect on the building itself, emits less heat during nighttime and can also take care of storm water. The green roof also has a good mitigation effect: plants absorb carbon dioxide and provide oxygen.

In a metropolitan area, the buildings keep radiating heat even at night which will lead to significantly warmer urban areas than surrounding rural areas. This phenomenon is known as **urban heat island effect (UHI)**. This situation can be critical in warmer than normal weather conditions (i.e. heat waves), with significantly higher death rates, especially among senior citizens. A green roof/wall is therefore a good measure against UHI since it has a well-known cooling effect.

Green structures and parks also have a cooling effect giving shadow during warm days and draining storm water.

3.3 Impact and vulnerability assessment

3.3.1 Information meeting

A way of initiating the process of climate adaptation is to start with an **information meeting**, aimed at municipal/regional officials (staff) and politicians. The purpose of such a meeting is to raise the climate change issue and disseminate knowledge about current and expected climate changes and possible effects in the specific area/region.

In the meeting experts will be asked to present *charts* of future climate projections (prognosis on mean annual temperature rise, precipitation, extreme weather conditions, floods, heat waves and so on). Experts and charts can be available from the national/regional weather service or equivalent institute.

If applicable, the meeting can also include a *workshop*, where the participants can have an overall discussion on the effects of climate changes in the different regional or municipal functions.

3.3.2 Project group

A second essential step of the process consists in **creating a project group with members from different departments and stakeholders with involvement of local expertise** (e.g. security, civil protection, water supply, energy, fire and rescue services, health care and city planners). Depending on size and structure of the organisation, it may be necessary to create thematic groups for each system (e.g. health, communications, technical supply, construction and building, agriculture and tourism, nature and environment). Available climate indicators will be presented to the project group, such as frequency of heat waves, increase in mean annual temperature, changes in precipitation and so on, as a basis for the assessment.

3.3.3 System definition

Start the assessment by defining and describing the **systems** to be analysed (Table 3.1).

Table 3.1 Examples of systems to be analised

SYSTEMS	
Roads	Building
Railroads	Heating/cooling in buildings
Electricity – Grids – Production	Settlement and developed land – Flooding – Landslides, erosion – Coastal erosion
Aviation	Health
Shipping	Agriculture
Communications	Forestry
Radio and TV distribution	Fishery
Hydropower	Natural environment
District heating	Water environment
Wastewater and storm water	Tourism and outdoor recreation
Drinking water	

When studying each system, you must take into account many different parameters. Each system may consist of several elements, so-called *system elements* (e.g. **system:** *Roads* may consist of the **system elements:** *roads, tunnels, bridges* and so on). For some systems, you may also need to specify various *system levels* (e.g. small/medium/large sized roads).

Other important parameters are the **lifetime of the system/system element, projections, redundancy and dependencies on other systems. Geographic features** are also often important, e.g. if a system element is near water, in a landslide sensitive area, and so on.

When doing the assessment you can choose to analyse only the systems that are relevant to the municipal or specific type of organisation.

3.3.4 Climatic threats

Climatic factors threatening the systems must be defined and analysed. What climate factors are relevant for each system? Is increased precipitation a threat to a system? Increased mean annual temperature? How detailed you choose to analyse each system, depends on the level of ambition (Table 3.2).

Table 3.2 Examples of climate factors that can pose a threat to various systems

CLIMATE FACTORS
Increased temperature: warmer and more warm days
Milder winters
Droughts
More/less precipitation
Heavy rain during short periods (hours/days/weeks)
Large water flows/ flooding
Longer growing season
Heat waves

In case you need to describe the system with different system elements and/ or system levels, do an assessment of threats to each system type/level. When you combine a system/system type/level with the climatic factors you can get different outcomes. It may be a negative or positive impact or no impact at all. The outcome depends on the system´s vulnerability and sensitivity to climate changes (Table 3.3).

Table 3.3 Example of brief outcome when combining systems with different climatic change factors

	COMMUNICATIONS	TECHNICAL INFRASTRUCTURE	BUILDINGS	AGRICULTURE, FORESTRY AND TURISM	NATURAL ENVIRONMENT	HEALTH
Increased temperature: warmer and more warm days	Increased corrision	Reduced heating requirements Slightly increased cooling needs of residential and commercial buildings	Changed need for ventilation, increased risk of moisture and mold damage	Increased need for ventilation in livestock buildings, favoured summer tourism	Climatic zones move north	Increased pollution and spread of diseases
Milder winters	Reduced maintenance costs		Increased risk of high flows and flooding due to precipitation during the winter	Pests may increase,less favourable conditions for winter tourism	Cold-water speices are disadvantaged and heat-resistant are favoured.	Increase in vector-borne diseases
Droughts, heat waves		Deterioration in raw water quality	Increased need for irrigation of gardens and parks	Increased risk of wildfire, increased need for irrigation	Indirect effects of changes in water management	Increasing pressure on healthcare
More precipitation	Increased drainage can affect the bearing capacity of road / railroad beams	Increased stress on the piping,changed conditions for hydropower generation	Increased water volumes to handle the stormwater system	Risk of increased nitrate leaching	Increased drainage increases the amount of particles in freshwater	
Heavy rain during short periods (days/ week)	Flooding and problems with storm water management can influence the accessibility	Risk of increased stress on the stormwater system	Increased problems for facilities and infrastructure that are vulnerable to landslides and floods	Increased pressure on drainage and land drainage		Increased risk of water-borne infections and contamination of drinking water
Large water flows/ flooding	May affect plants and distribution grids near the water		Increased flood risk, more frequent flooding			Risk of injury in case of flooding
Longer growing season		Positive for biomass growth	Increased growth of weeds may increase the use of pesticides	Prolonged period of growth for agriculture and forestry	Changed conditions for the ecosystem, flora and fauna	Prolonged pollen season

3.3.5 Assessment of consequences

Next step is to assess if the consequence is acceptable or not. A consequence which is not acceptable needs to be addressed and it can be listed by severity of the consequence. In this assessment of the level of acceptance it is important to also consider its importance to society (Table 3.4).

Table 3.4 Factors that affect the severity/consequence of a threat

CONSEQUENCE/SEVERITY	EXPLANATION
Geographic area	How much area is affected? Which area is affected? The nature of area (urban/rural etc.)
Magnitude	How many/much is affected? In what way?
Intensity	Persons killed/seriously injured/slightly damaged/discomfort, etc.
Duration	How prolonged is the consequence?

The unacceptable consequences are a description of the system´s vulnerability to climate change and society´s dependence on this system.

Positive consequences are an interesting outcome of an impact- and vulnerability assessment. They are considered as possibilities because they involve future potentials.

3.3.6 Time counts

An impact- and vulnerability assessment must also consider what consequences are expected to occur in relatively **short** time (within 25-50 years) and **long** time (within 100 years).

To make the impact- and vulnerability assessment easier to grasp, the different factors can be put together in a chart. (Table 3.5). The column with proposed measures can also be used in the next part of the climate adaptation planning process - the *measures- and cost assessment*.

Table 3.5 Draft template of an impact- and vulnerability assessment matrix of the system "Health"

SYSTEM	TIME PERSPECTIVE	CLIMATE FACTOR	VULNERABILITY	MEASURES
Health	Short time (25-50 years)	• • • •	• • • •	• • • •
	Long time (100 years)	• • • •	• • • •	• • • •

3.4 Measures and cost assessment

What are the appropriate measures to be taken in order to prevent negative impacts caused by climate changes? What will the cost be and who is responsible? For the impacts that are assessed as negative you must systematically proceed to examine what measures are possible and appropriate (Table 3.6).

- **Cost estimates** are important because in a later stage it will be easier to prioritise actions. Proposal for funding can be mentioned if applicable. Also the possible **cost of inaction** should be evaluated and compared.
- **The time perspective** is important in assessing the actions required as well as when they need to be implemented with respect to both climate change itself and to the system.
- Actions often make an impact beyond the intended, both positive and negative. **A summary of all proposed measures provides an overview,** where action can be most effective and/or make least damage.
- **The positive consequences**, which can be opportunities, should be analysed in a similar way as the negative ones.
- **Regarding the issue of responsibility**, it is important to clarify who is responsible for implementations of various measures.
- **Collaboration** on shared responsibilities is important.

Table 3.6 Draft template for cost and responsibility account, including appropriate time for actions

MEASURE	BENEFITS OF MEASURE	RESPONSIBILITY	TIMETABLE FOR IMPLEMENTATION	COST	FINANCING

3.5 Tool: draft structure and contents of a municipal climate adaptation plan (can be adapted to a region)

- Climate change and adaptation
  - Explain why adaptation is necessary
  - Describe the purpose of adaptation planning
  - Methods used/processes
  - Objectives and definitions (limitations)

- Municipality´s role and current position/situation
  - Explain the municipality´s role in the climate adaptation planning process
  - Describe, if applicable, the municipality´s climate and/or energy strategies
  - What has been done so far in the municipality, when it comes to climate adaptation?
  - What still needs to be done?
  - Describe if the adaptation plan is divided into different areas due to the municipality's diverse geography
  - Describe what characterises these areas
  - Describe population structure and how it is distributed across the municipality
  - Describe the overall municipal building structures, infrastructure and recreational areas/scenery

- Climate changes in the municipal/region - Scenarios
  - Describe in broad terms what the climate material used is based upon, where the information is coming from, the climate and emission scenarios used and the time horizon of interest

- Climate factors affecting the municipality
  - Describe the climate factors that are relevant to the municipality
  - Describe for each climate factor if and how there will be a change from the current situation, and approximately how large the changes will be
  - Display maps, charts and graphs to enhance clarity

The following climate factors may be relevant:

- *Temperature:* annual mean temperature, seasonal temperature, warm days, number of heat waves, freezing point crossings, ground frost, humidity, combined with high temperature
- *Precipitation:* annual mean precipitation, seasonal rainfall, heavy rainfall, prolonged rainfall, short-lived, intense rainfall, droughts, snow cover (prevalence, water content), ice accretion (including freezing rain)
- *Flows:* mean flows, seasonal average flows, 100-year flows, dimensioned flows
- *Groundwater conditions*
- *Vegetation period:* length and start
- *Sea level:* medium tide, high tide position
- *Wind:* mean wind speed, wind gusts

- Summary of the future climate
  - Summarise the major changes to the municipality
  - What are the main/biggest challenges?

- System types and consequences of a changing climate – threats and opportunities
  - Describe the overall critical systems and activities in the municipality
  - Describe the above systems:
    - Generally what climate changes means to the system
    - The climatic factors that affect the system

- If there are different types of systems, any system level, lifetime, redundancy and where it is located geographically
- How the system / system type is affected
  - positive effects
  - negative effects
- If the consequence is negative - are the consequences acceptable or unacceptable

Remember to consider the time perspective for both the system and for the climate changes.

- Possible measures, costs and responsibilities
  - Describe for each considered system:
    - What measures may be possible and appropriate in terms of negative impacts, type of action (prevention, emergency action, damage mitigation)
    - When the measure needs to be implemented (today, in short time, in long time)
    - How much will the measure cost
    - What effect/benefits will the measure present
    - Who is responsible for implementing the measure
    - List the positive consequences and how they can be developed
    - What actions are needed to take advantage of the positive consequences
    - The cost for the positive consequence
    - What effect/benefits will the measure present
    - Who is responsible for implementing the measure

- Responsibilities

After all assessments have been made, the material may eventually also be presented on the basis of responsibility. For every responsible part, list all the measures, their costs and time for implementation.

Please define here also the plan review process and timing

Annex 1. Glossary

ADAPTATION. In the climate jargon adaptation means adjustment of natural or human systems in response to current or expected climatic stimuli or their effects, in view of moderating harm and/or exploiting opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation. IPCC devotes to this subject the second volume of its assessment report.

AEROSOL. Dispersion in the atmosphere of particles of different origin like pollen, soot, salt crystals, sand, etc. The presence of aerosols alters the optical properties of the air, making it less transparent to sunlight. Aerosols tend to contrast the warming effect of greenhouse gases.

AGRICULTURE. Production of food, fibre, and (recently) energy (ethanol, biogas, biomass), using cultivated plants and livestock. Greenhouse gas emissions from intensive agriculture, characterised by high yields, arise mainly from the production and use of synthetic fertilisers (CO_2 and nitrous oxide) and from the mechanisation of agricultural operations (CO_2), as well as from cattle and rice paddies (methane). Agriculture is also by nature very sensitive to the consequences (not always negative) of climate change, to which it must constantly adapt with new species and varieties, irrigation, etc.

ATMOSPHERE. Gaseous layer surrounding the surface of a planet. The terrestrial atmosphere is composed mainly by nitrogen (78%), oxygen (21%) and other minor gases (1%), to which water vapour is added in a highly variable amount (1 - 5 %). The lowest layer (up to 10-15 km) of the atmosphere, where most weather phenomena take place, is called troposphere, followed by a second layer called stratosphere.

BIOCHAR. English neologism indicating wood charcoal obtained by pyrolysis from wood and plant debris. The incorporation of this material in soils improves their agronomic characteristics, and enables to permanently sequester the carbon dioxide absorbed by the plants whose tissues are processed into charcoal. According to some scholars, the production of biochar should be encouraged and spread to all areas of agriculture, since the pyrolysis process can produce energy without emitting carbon, and the use of biochar could effectively reduce if not eliminate the GHG emissions of the agricultural sector.

BIOGAS. Gas (mostly methane) produced by anaerobic digestion of plant and animal wastes. It is used for generation of renewable heat, electricity and vehicle fuel. The cultivation of agricultural land for the sole purpose of producing plants for biogas is highly controversial.

BIOMASS. Timber and other plant material used for generation of heat and/or electricity. The usefulness of biomass-fuelled energy plants is to be demonstrated on a case by case basis, taking into account the origin of biomass (for example, there is a substantial difference if it consists of waste from local production of timber or instead it derives from the uncontrolled destruction of tropical forests). Also important is the assessment of air pollution caused by power plants themselves.

CARBON. Chemical element at the base of life, characterised by atomic weight 12 (there's also an important isotope of atomic weight 14) and with a large capacity to combine with itself and with other elements. Organic chemistry studies the chemical reactions of carbon also in order to develop synthetic products such as gasoline, plastics etc. Carbon is currently released in the atmosphere by human combustion and land use change activities (deforestation) at the alarming rate of 10 Gton/year (2010).

CARBON DIOXIDE. Gas present in traces in the atmosphere, formed by two atoms of oxygen and one of carbon (CO_2). Essential for life on planet Earth as it enters in the primary production process of photosynthesis. It is also an important greenhouse gas released in combustion processes, whose concentration rose from the pre-industrial atmospheric level of 280 parts per million (ppm) to the current 392 ppm (2012). The rate of increase of CO_2 reached around 2 ppm per year, arousing international concern about the feared climatic consequences on our planet's temperature, which is also increasing. According to the projections of the IPCC temperature could rise by several degrees during this century if mitigation actions are not quickly and drastically taken to limit the emissions of anthropogenic CO_2 and other greenhouse gases.

CLIMATE. Set of weather conditions characterising a specific land or sea area. According to the WMO normal weather conditions and climate variability of a site must be determined by processing the climate data (temperature, precipitation, wind, etc.) collected in at least thirty years from gauging stations located according to appropriate rules. The Earth's climate is not constant, as both the most recent data show and the geological record, with evidence of ancient glaciations, the last of which ended about 12 thousand years ago. Geological climate change is due to the regular oscillations of the Earth axis and its orbit around the sun (Milankovitch cycles) and to changes in the solar constant. Significant climatic effects may also be due to large volcanic eruptions injecting large amounts of aerosols into the stratosphere, and to a lesser extent the impact of meteorites. With the industrial revolution, and particularly after World War II, very considerable amounts of carbon dioxide and other greenhouse gases were released into the atmosphere for the production of energy and because of tropical deforestation, leading with high probability to the changes we are witnessing, consisting essentially in the increase of global temperature, the melting of glaciers, ice caps and permafrost, the rising of sea level, and an increasing intensity of extreme events such as hurricanes, floods and droughts.

CLOUD. Large clusters of water droplets and/or ice crystals suspended in the air. Clouds originate from the condensation of water vapour, induced by the lifting of a mass of moist air and its consequent cooling. An essential role in the formation of clouds is played by aerosols, activating the condensation and consisting of oceanic salt particles or dust of different origins. Cloud formation can occur on mountains or in meteorological fronts, where air masses of different origin, temperature and humidity collide. The presence of clouds rises dramatically back reflection of solar radiation, cooling the areas below, but clouds also intercept thermal infrared radiation emitted from the Earth reducing its cooling rate, so their role in climate is very complex. Precipitation from clouds may result in rain, hail and snow, thus constituting an essential element of the water cycle on the planet.

COAL. Solid mineral of organic origin very rich in carbon, derived from the subsoil in different forms (anthracite, bituminous coal, etc.), or obtained by pyrolysis of wood (charcoal). Once used mainly for the production of heat and steam is now mainly used in large quantities for the production of electricity. When burned, it releases large amounts of carbon dioxide (3 kg CO_2 per kg of coal) and heavy metals harmful to the environment and human health.

CRUDE OIL (PETROLEUM). Fluid of organic origin found underground and sometimes outcropping at the surface, that once distilled and chemically transformed provides many important fuels (gasoline, diesel, fuel oil etc.) and very diverse other materials (bitumen, plastics). The industrial exploitation of oil began in the nineteenth century and has experienced tremendous growth since World War II. Current daily world consumption of oil is around 85 million barrels (2009). Many scholars fear that the availability of oil is approaching a peak beyond which its supply will begin to decline rapidly. According to some of them the peak has already been reached.

DEFORESTATION. Uncontrolled felling of forests, in particular tropical rain forests in the Amazons, Indonesia, Congo, etc. but also widespread in temperate forests of Canada, USA, Russia etc. In addition to the release of carbon dioxide due to burning of tropical wood, tillage after deforestation causes the emission of large amounts of carbon previously sequestered in forest soil. Deforestation is currently the main cause of global climate change after the production of energy from fossil fuels. It has also very deep consequences on local populations and biodiversity.

DIESEL. Fuel oil obtained from petroleum. The combustion of a litre of diesel fuel results in the production of about 38 MJ of energy and the emission of about 2.8 kg of carbon dioxide. Biodiesel obtained from vegetal oil can substitute, or be added to, conventional diesel to reduce its GHG emissions, though its actual effectiveness is still controversial.

ELECTRICITY. Useful form of energy derived from the movement of electrons in metallic conductors. The systematic exploitation of electricity began in the nineteenth century, when the energy of falling water through turbines was transformed into electricity (hydroelectricity). Currently electricity is mainly produced by burning fossil fuels (coal, natural gas, fuel oil) in power plants. Other sources are nuclear power, where energy is produced using the atomic fission of uranium, wind power plants, geothermal power plants, and solar power plants. Electricity can be stored in limited amounts in batteries but essentially it must be produced during consumption and distributed by means of extensive grids joining power plants with users. New "smart" grids are being implemented in some countries to manage the diffuse generation of electricity from sparse renewable power plants (wind farms, solar panels, biomass/biogas burners etc.)

EMISSIONS. In climatology this term refers to the greenhouse gases released into the atmosphere directly or indirectly as a result of human activities, in particular the consumption of energy, agriculture and deforestation. The current level of emissions expressed as equivalent carbon dioxide is 30 billion tons a year, a level considered to be approximately twice the natural ability to be absorbed by the oceans and vegetation. The yearly emissions of greenhouse gases per person are a bit more than 4 tonnes globally, but vary a lot from country to country ranging from less than 1 ton in Africa to more than 50 tons in the Gulf area.

ENERGY. Measured in joules (J) is the capacity to do work (i.e. for example to set in motion heavy objects or to heat a fluid). The primary source of energy on Earth is solar radiation, heating land and the oceans, activating photosynthesis in plants and green algae, inducing evaporation and activating the water cycle. The uneven heating of the Earth's surface by solar radiation is also at the origin of winds and other weather phenomena, ocean currents, and climate diversity. Man has long used (and continues to use) wood as an energy source. Fossil energy has been used for nearly two centuries. Energy can be measured in other units than joules, for instance as watt hours (Wh, equal to 3600 J) and multiples (kWh, Mwh, GWh, etc.). In economical statistics energy is also expressed as TOE (tonnes of oil equivalent, each equal to about 11.6 MWh).

ENERGY EFFICIENCY. Energy is needed in our communities for heating, lighting, processes, transport etc. However, no matter what we need energy for, and no matter what kind of energy it may be, it is important that the energy is not wasted. To use as little energy as possible to gain the maximum output as possible, is efficient use of energy.

ETHANOL. Alcohol obtained by distillation of agricultural products with high sugar content. It can be used as a vehicle fuel instead of, or combined with, gasoline. Depending on the source chosen for ethanol production, the reduction of GHG emissions compared to fossil fuels is more or less efficient. In a few inefficient cases, emissions can even be worse.

EVAPORATION. Transformation of water from liquid to vapour. It requires significant amounts of energy, corresponding to 2.4 MJ / kg (latent heat of evaporation). The inverse process, said condensation, generates the release of the same amount of energy.

GASOLINE. Fuel produced from the distillation of petroleum. The combustion of one litre of gasoline produces about 35 MJ of energy and emits approximately 2.3 kg of carbon dioxide.

GREENHOUSE EFFECT. Increase of the equilibrium temperature of the surface land due to the presence in the air of greenhouse gases. Without the greenhouse effect the Earth's surface would be at an average temperature of about -18 °C, similar to that of the moon, rather than the current level of about 14 °C.

GREENHOUSE GASES. Atmospheric gases capable of absorbing and re-emitting thermal infrared radiation. Greenhouse gases are the cause of the greenhouse effect. The most important GHGs are water vapour, carbon dioxide and methane. Other greenhouse gases regulated by the Framework Convention on Climate Change (UNFCCC) are: nitrous oxide, perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), and sulphur hexafluoride (SF 6).

HEAT. Form of energy related to the speed of movement of molecules in a fluid or vibration of the same into a solid. The transmission of heat is regulated by the temperature of the bodies and can take place by conduction (direct passage for contact between bodies at different temperatures), convection (by means of turbulent flows of air), and radiation emission in the infrared.

IPCC. Intergovernmental Panel on Climate Change, a cooperative scientific organisation, founded in 1988 and funded by the United Nations, through the UNEP and WMO, which reviews global climatological literature, draws scenarios of anthropogenic greenhouse gas releases and projections about the future of the climate on Earth. IPCC issues with irregular periodicity so called Assessment Reports. The fourth AR was issued in 2007, while the next one is due in 2013.

KYOTO PROTOCOL. International treaty implementing the UN Framework Convention on Climate Change, which provides for reductions in emissions of greenhouse gases in the signatory countries and the return to levels below those of 1990 within the five years 2008-12. For the European Union the Protocol requires an 8% decrease of emissions, a level higher than that of the general protocol (-5.2%). The Protocol entered into force in early 2005 after the ratification by Russia. The United States and other industrialised countries, who had also signed the Framework Convention and the Protocol, have subsequently refused to ratify it, fearing damage on their industrial systems. In addition to the actual reduction of emissions, the Protocol, at the time the subject of a hard negotiation, involves complex exchange mechanisms (emission trading), and reduction of emission quotas in exchange for clean energy projects in third countries (Clean Development Mechanism) or JI (Joint Implementation) between signatory countries and third countries. The protocol, despite being the first concrete example of an international effort aimed at reducing greenhouse gas emissions, is considered by many largely insufficient for limiting the global temperature increase within two degrees in 2100, and new agreements should follow within year 2020, also involving the U.S. and newly industrialised countries and large emitters like China, according to results from the UNFCCC conference in Durban (December 2011).

METEOROLOGY. Science that studies the atmosphere, mainly in order to predict its phenomena. Weather forecasting is based on daily runs of very large mathematical models, usually carried out in public national or international centres. Europe organised and supports the Ecmwf (European Centre for Medium-range Weather Forecasting), located in Reading, UK.

METHANE. Gas formed by molecules of carbon and hydrogen (CH4) which is mostly found underground mixed with other gases to form the so called natural gas, widely used for the production of energy. Methane in the atmosphere is present in traces but it is an important greenhouse gas whose effectiveness on 100 years (global warming potential) is 25 times that of carbon dioxide. The concentration of atmospheric methane is increasing (1750 parts per billion, or ppb, compared with pre-industrial 700 ppb). Sources of emissions are agriculture (ruminant animals, rice paddies), waste landfills and asphyxiated reservoirs such as wetlands and reservoirs upstream of hydroelectric plants. Massive quantities of methane are trapped in permafrost and may be released in an uncontrolled way if this continues to melt. The combustion of one cubic meter of natural gas involves the emission of about 2 kg of CO_2. Biogas is mostly composed by methane.

MITIGATION. In the climate jargon mitigation means to identify and implement the best methods for reducing emissions of greenhouse gases in the atmosphere so as to reduce the human impact on Earth's climate. The main mitigation strategies have to do with energy efficiency, substitution of fossil fuels with renewables, and reforestation. IPCC devotes to this subject the entire third volume of its assessment report.

NITROUS OXIDE. Greenhouse gas formed by nitrogen and oxygen (N2O) also known as laughing gas, used in medicine as anaesthetic. It is released into the atmosphere as a result of nitrogen fertilisation of agricultural fields. It is a very powerful greenhouse gas (global warming potential 300, i.e. about 300 times more effective than CO_2) regulated by the UNFCCC.

PERMAFROST. Scientific neologism indicating the permanently frozen soil found in the arctic areas of Siberia and Canada. The thawing of permafrost for the rising temperatures in those areas causes considerable consequences on both the outflow of freshwater to the Arctic Ocean and the stability of land and human works (buildings, roads) that rely on it. Many scientists are afraid of the release of large amounts of CO_2 and methane into the atmosphere due to the melting of permafrost, which could result in the activation of an uncontrollable (runaway) global warming.

PRECIPITATION. Phenomenon consisting in the fall to the ground of liquid and/or solid water (rain, hail, snow) coming from the clouds. The yearly global average precipitation is around 1000 mm, equivalent to one ton of water per square meter. Very arid areas like deserts have average annual rainfall below 100 mm, while areas of high rainfall, such as relief typically exposed to moist air masses of marine origin, may exceed 3000 mm/year. On land, the precipitation water can be drained away from the surface by rivers and lakes, can infiltrate and feed deep aquifers, can result in evaporation from wet soil or directly through plants (transpiration).

PYROLYSIS. Process of chemical transformation of organic tissue and other materials which occurs at high temperatures in the absence of oxygen. Traditionally pyrolysis is used in charcoal production to convert masses of wood timber in lighter and more durable fuel. Efficient pyrolytic equipment of different sizes are now available on the market.

SOLAR CONSTANT. Solar radiation flux on a surface perpendicular to the sun rays, at the distance of Earth from the sun, outside the atmosphere. It is equal to 1367 W/m^2, with weak oscillations due to the level of solar activity, as shown by the varying number of sunspots appearing on its surface.

UNEP. United Nations Environmental Program, based in Nairobi, Kenya, supporting the IPCC.

UNFCCC. Body of the United Nations located in Bonn, Germany, presiding over the implementation of the Framework Convention on Climate Change adopted in 1994. The Convention is implemented by means of protocols signed in periodic international conferences, the most important of which was the Kyoto Protocol, signed in 1997, entered into force in 2002, valid until 2012.

WATER VAPOUR. A potent greenhouse gas of natural origin. It condenses in the atmosphere and gives rise to clouds and fog. One of the effects of global warming is the increase of evaporation from the oceans, which in turn produces an increase of the greenhouse effect (positive feedback loop).

WMO. World Meteorological Organisation, in the United Nations from 1951, with headquarters in Geneva, Switzerland. It regulates the collection and exchange of meteorological and climate data. Chairs together with UNEP the organisation and funding of IPCC.

Annex 2. Are you climatewise?

A small test to be taken before and after reading this book
(care of Piotr Klementowski, city of Jelenia Góra, and Vittorio Marletto, Arpa Emilia-Romagna)

Do you agree with the opinion that 30 years ago or more the winters in your area were longer and colder?

- ❏ Yes
- ❏ No

How many floods were there in your region in the last 10 years?

- ❏ Less than 3
- ❏ Between 4 and 7
- ❏ More than 7

Do you agree with the opinion that in the last 5 years tornadoes have occurred in your region?

- ❏ Yes
- ❏ No

Which one of the following is connected with Kyoto Protocol?

- ❏ Reduction in emissions of greenhouse gases
- ❏ Reduction of oil extraction
- ❏ Reduction of nuclear power stations

Are you aware of the global warming issue? Can you shortly describe it?

. . . .

. . . .

Is global warming caused by

- ❏ The ozone layer hole?
- ❏ Emissions of pollutants?
- ❏ Emissions of greenhouse gases?

How do you think global warming issue should be managed? Can you shortly describe this?

....

....

Do you know what mitigation and adaptation mean? Can you shortly describe them?

....

....

Do you know and can you describe any policy you supported that helps to counter climate change?

....

....

General information
This material may not be used by political parties, their candidates or election workers for electoral advertising purposes during a period of six months before upcoming elections. This applies to all elections. Especially, it is not allowed to distribute this material during electoral campaigns or at information stands of political parties, or to add political party information by inserting, printing or pasting advertising materials or labels into or onto this information material. It is also prohibited to communicate this material to third parties for electoral advertising use.

Also when there are no upcoming elections, the present material may not be used in any way that might be understood or interpreted as the issuer's support for individual political groups.

The foregoing restrictions apply regardless of what distribution channel is used, i. e. independently of how and how many copies of this information material were received. However, political parties are allowed to use this information material for instructing their members.

EnercitEE is co-financed by the European Development Fund (ERDF) through the INTERREG IVC Programme.
The contents of this Handbook reflect the authors' views, neither the Managing Authority nor the Saxon State Ministry for the Environment and Agriculture, as Lead Partner of EnercitEE, are liable for any use that may be made of the information contained.

EnercitEE – SubProject CLIPART

CLImatic Planning And Reviewing Tools for regions and local authorities