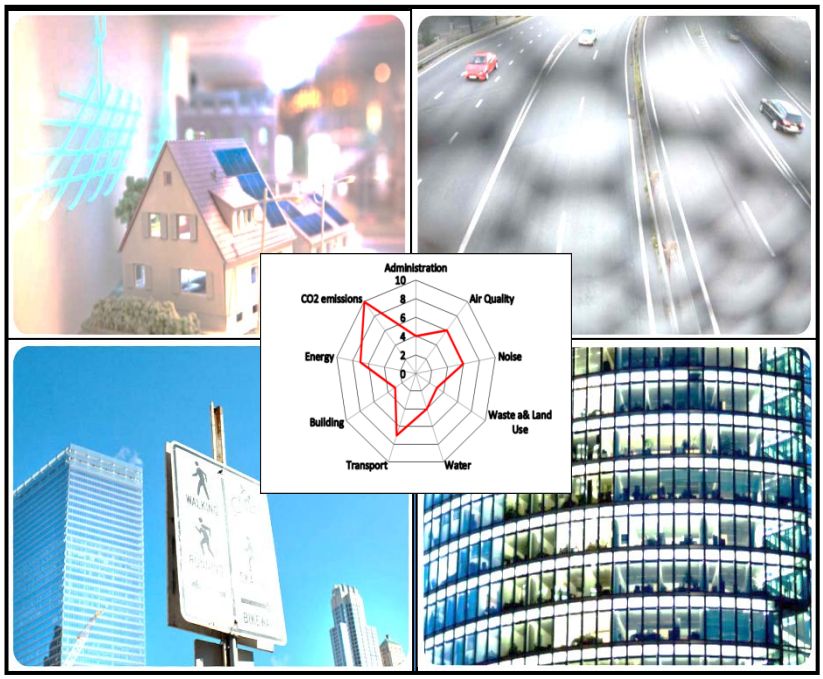
Analysis of co-benefits of air pollution, noise and climate change policies on a local scale



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< Source: copyrights by Oeko-Institute, 2012, Mega city projects focus mainly on the residential, transport and industry sectors for reducing CO_2 emissions by implementing action plans on local level.>

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Analysis of co-benefits of air pollution, noise and climate change policies on a local scale

Part 1

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1 Introduction

1.1 Man-made Pollution

Climate change (CC) is one of the top ten topics discussed in global media today. In the light of the projected increase in the global temperature by approx. 2°C by 2050 major problems will increasingly occur all over the world. For a long time there was much controversy about whether the temperature increase results from man-made. But several scientific studies could verify the relationship between temperature increase and man-made activity. An increasing temperature causes reduced water availability by decreasing of rainfall and the increasing intensity of heat waves affect air pollution and above all human health. Alongside the effects of pollution the increase in temperature results in more deaths.

The effect of greenhouse gases (GHG) like carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) and furthermore water vapour and ozone on the atmosphere is to absorb and emit radiation within the thermal infrared range. This process is the so-called greenhouse effect. Other GHGs in the atmosphere are entirely man-made such as the halocarbons and other chlorine- and bromine-containing substances.

Air pollutants (AP) like fine particles (particle matter, PM), in particular black carbon, also have impacts on climate change effects and thus on human health. As an example black carbon (BC) is a climate forcing agent; emissions occur due to incomplete combustion of fossil fuels or biofuel from anthropogenic as well as from natural sources. With its global warming potential the earth atmosphere absorbs heat and reduces the albedo.

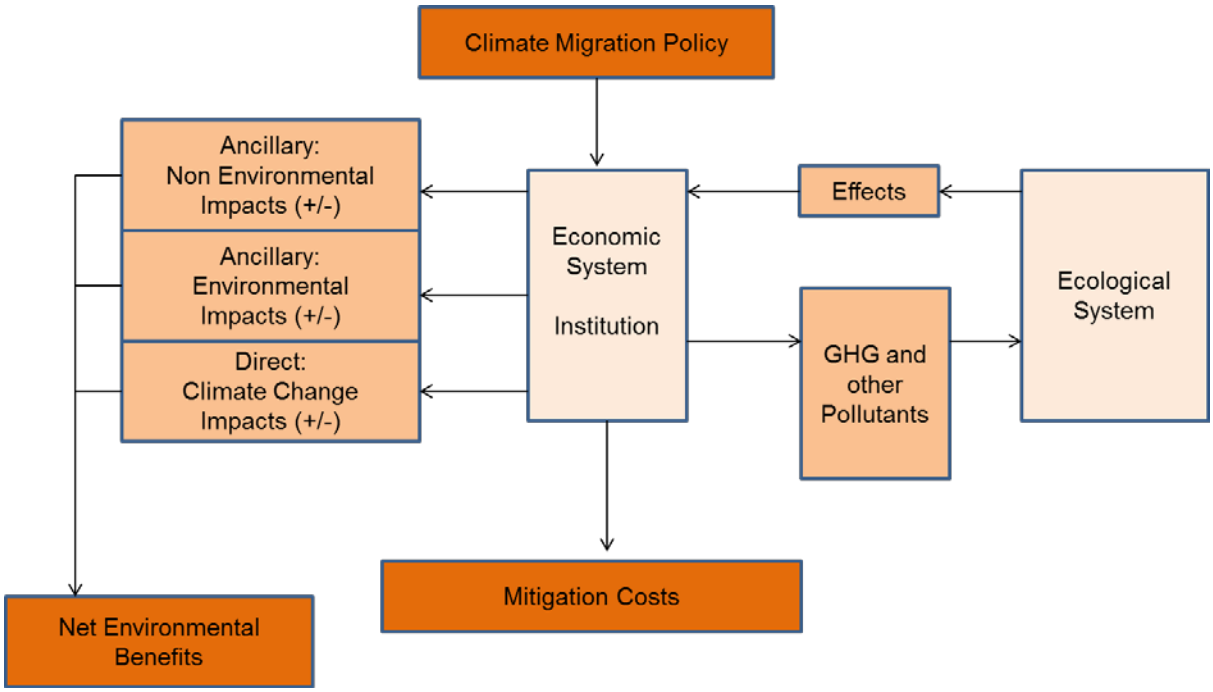
Further primary air pollutants are sulphur dioxide (SOx), nitrogen oxides (NOx) and volatile organic compounds (VOCs). With their chemical reactions in the atmosphere they influence the formation of ground level ozone or causes eutrophication in the aquatic environment. In the industrialised countries, they are mainly produced by the energy and transportation sectors (Slanina and Hanson, 2006).

Both, greenhouse gases and classical air pollutants mostly have the same sources and their emissions interact with the atmosphere. Together, they cause a variety of environmental effects on the local, regional or global levels (IPPC 2007, Fourth Assessment Report, Chapter 11.8.1.), but there are differences on local and temporal levels between air pollution control and climate change effects. Air pollution occurs earlier and closer on ground level while climate impacts affect in long-term and globally. Ways in which noise effects could be

reduced by CC or AP mitigation strategies are not discussed further. But with the implementation of better technologies (e.g. electric vehicles) which goes along with of reducing CC/AP, noise can be reduced as well.

Since the third assessment report (TAR) by the Intergovernmental Panel on Climate Change (IPCC) in 2001 was published, the co-benefits of climate change mitigation policies and air pollution control have been discussed (see chapter 7.2.2.3 Ancillary Benefits and Costs and Co-benefits and Costs, IPCC TAR). Numerous scientific publications and studies have underlined a variety of co-benefits of greenhouse gas mitigation on air pollution for industrialised and developing countries.

Figure 1-1 Mechanism for the Generation of Ancillary impacts



Source: IPCC TAR 2001, WG3, Mitigations, chapter 7.2.2.3, Fig. 7.1

The above figure (Figure 1-1) of the IPCC TAR presents the development of ancillary benefits of GHG emission reduction policies. The definition of "ancillary impacts" reflects that in some cases the benefits might be negative and from the perspective of policies the abatement of local air pollution caused by GHG mitigation might be an additional benefit.

As it is mentioned the economic and institutional system within a country influences the reductions in GHGs, changes in other pollutants, and mitigation costs. Changes in GHG emissions in turn lead to changes in air and water pollution, which ultimately extend throughout the environment and feed back into the economy. In many cases, when measured using standard economic techniques, the health and environmental benefits add up to substantial fractions of the direct mitigation costs. For an example decarbonisation strategies could lead to significant direct cost savings because of reduced air pollution costs.

Another polluter is noise, defined as human, animal, or machine-created environmental noise, that harms and stresses the activity or balance of human or animal life. The definition is pursuant to the Directive 2002/49/EC article 10.1. This directive should give a common approach for avoiding, preventing or reducing the harmful effects of environmental noise. The main target is integrated noise management. In the first step the competent authorities in the European member states had to produce strategic noise maps for major roads, railways, airports and agglomerations. The second step is to inform and consult the public. The third step is to produce local action plans to reduce noise. In general, noise is not considered together with climate change or air pollution.

1.2 Impact from Cities

The increase of population living in urban areas continues, especially in the developing world. Close to half of the world's population now lives in urban areas (TAR, 2001) and most cities with more than 1 million inhabitants are in the developing world where cities will reach a size around 10 million inhabitants. As it is mentioned in the TAR the future world might be less dominated by "megacities" (cities with a population of over 10 million population) than previously predicted. Nevertheless, this dramatic trend contributes to local air pollution and to GHG emissions. Trends toward urbanisation mean that the impacts of climate change on human settlements in most countries, if they occur, will increasingly affect urban populations, not rural or traditional settlements (TAR, 2001, chapter 7.2.1, http://www.grida.no/publications/other/ipcc_tar/?src=/climate/ipcc_tar/wg2/308.htm).

Taking into account that two thirds of the world's energy is consumed in cities and that this share has been forecasted to increase further to 73% by 2030 (IEA/OECD 2008, p. 179) the responsibility of cities to enforce mitigating climate change policy is unavoidable. Accordingly, cities have a major role to play in monitoring and reducing GHG emissions and mitigating climate change. If Europe wants to succeed in reducing its GHG emissions by 20% up to 2020 it will require close monitoring of the policies and measures at the Member State (MS) level, in particular in the non-ETS sectors under the Effort Sharing Decision (Decision 406/2009/EC) and cities have to adopt their policies on that goal.

Meanwhile, the challenge to implement these strategies is for many cities courteous and therefore, they take part on megacity projects for offering their inhabitants sustainability and green life style. The adoption of the Leipzig Charter on Sustainable European Cities (2007) and the launch of the Covenant of Mayors (2009) showed that many cities are well prepared in terms of climate policy.

1.3 City Projects

Since the early 1990's major cities have joined forces to build international networks. 'Eurocities'[1] is one of them and supports the exchange of best technologies between advanced cities and cities that do not yet have a complete strategy as mentioned in the Commission's white paper on climate adaptation in 2001. From 2005 onwards with the

[1] http://www.eurocities.eu/eurocities/home

‘declaration on climate change’ local authorities assumed responsibility of implementing sustainable systems. The ‘Green Digital Charter’ was launched at the end of 2009 and should encourage cities to reduce the carbon footprint of their information and communication technologies (ICT) which lead to more energy efficiency in areas such as buildings, transport and energy. The charter carries more than 20 signatories and is supported and promoted by the EUROCITIES-led Networking intelligent Cities for Energy Efficiency (NiCE) project, which began in September 2011.

Five key challenges are always in the foreground of all the initiatives:

Energy efficiency by

- incentive renovation and insulation of private buildings where possible;
- improving public transport and overall urban transport management;
- investing in more energy efficient heating and cooling, such as through district heating and cooling, and seasonal thermal storage;
- increasing energy efficiency of public lighting, for instance through the installation of LED lighting.

Green growth by

- a shift toward a development where environmental protection and economic growth complement each other.

Innovation by

- the cities and their partners are also leaders of ‘public’ and ‘social’ innovation, themselves significant drivers of Europe’s global competitiveness and city success.

Mobility by

- implementing a fully integrated approach linking transport, environment and economic development.

Smart cities by

- utilisation of networked infrastructure to improve economic and political efficiency and enable social, cultural and urban development. Smart cities can be identified (and ranked) along six main axes or dimensions. These axes are: a smart economy, smart mobility, a smart environment, smart people, smart living, and, finally, smart governance.

City initiatives or projects are presented in this study in detail and are analysed in terms of their objects, action plans and methodology. To get a good overview of the emission sources and their respective reduction potentials cities need appropriate tools to establish a GHG emissions inventory. As a result, action plans to reduce GHG emissions at local level can be prepared and better conducted (Bader and Bleischwitz, 2009). This paper takes into account

that international city networks as well as national initiatives have developed such tools at local level.

1.4 EU Directives

The important directive is surely the 'Effort Sharing' Decision No 406/2009/EC on the effort of Member States to reduce their greenhouse gas emissions (see here Article 28 and 29, so that "in addition to individual Member States, central governments and local and regional organisations and authorities, market actors — together with households and individual consumers — should be involved in contributing to the implementation of the Community's reduction commitment, irrespective of the level of greenhouse gas emissions which can be attributed to them."). The implementation of clean air, water and ambient policies in cities were supported by several EU directives (e.g. National emissions ceiling[2], NEC, Directive or Directive 2008/50/EC, Clean air for Europe, CAFE) which will be broken down on local level. Most of them are characterised by new measurement campaigns, technology standards and best available techniques (BAT) (see air and water quality and waste water handling, noise). Other directives regulate the energy consumption among end users and energy suppliers (e.g. energy efficiency, ecodesign, F-gas regulation). All of these directives or regulations focus on abatements strategies for establishing healthy and better environmental conditions in cities. The following directives are the main pillars for the implementation of the European Union (EU) energy and climate program:

- Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe entered into force on 11 June 2008 (CAFE);
- Council Directive 2008/1/EC of 15 January 2008 concerning integrated pollution prevention and control;
- Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants;
- Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from Large Combustion Plants;
- Directive 2000/76/EC of the European Parliament and of the Council of 4th December 2000 on the incineration of waste;
- Directive 2002/49/EC article 10.1.: Issue action plans aiming at improving the noise situation;
- Directive 2003/17/EC of the European Parliament and of the Council of 3 March 2003 amending Directive 98/70/EC relating to the quality of petrol and diesel fuels;

[2] NEC objective is: to limit emissions of acidifying and eutrophying pollutants and ozone precursors in order to improve the protection in the Community of the environment and human health against risks of adverse effects from acidification, soil eutrophication and ground-level ozone. (see here http://rod.eionet.europa.eu/instruments/522)

- Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products;

- Energy Performance of Buildings Directive / Directive 2002/91/EC and Directive 2002/91/EC: (European Commission 2008b);

- Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC;

- Regulation (EC) No 842/2006 of the European Parliament and of the Council of 17 May 2006 on certain fluorinated greenhouse gases.

1.5 Methodology

This research project examines the international city networks and national initiatives that have developed emission inventories or sustainable instruments at local level, many of which are comprehensive and display a great variety of different functions. The growing amount of material available on how to construct and implement mitigation and adaptation policies lead to a need for comparative analysis and assessment. Thus, the main aim of the project is to obtain a good understanding and overview of the results of studies that have already been performed in this area. Another aim of this study is to examine whether local GHG inventories are comparable, and if not, how greater comparability could be achieved. These methodological challenges provide a basis for the identification of the main points from which differences between inventories could stem.

The first section of the project compiles existing initiatives and projects which have been assessed regarding local initiatives in the CC/AP mitigation field and provides an overview of the way the project was managed, the project's objectives and what the outcome of the campaign was. Secondly, if an emission inventory on local level has been compiled, it is examined which pollutants and sectors were analysed and what kind of methodology or guidance was applied. And thirdly, if information on policies and measures was considered and co-benefits between AP, CC or noise regulation were linked is also examined. Finally, findings of the projects are summarised.

In section two, critical variables for the analysis of local GHG inventories are inferred from section one. For the analysis a matrix was developed; as an example the following questions were specified:

- How do the methodologies which underlie different GHG inventory tools differ?
- What variables (activity data, emissions) were considered in the inventories and are available?
- Can different GHG inventory tools be compatible - and/or interoperable?
- Is the methodology applied comparable?
- Is a qualitative vs. quantitative analysis of the effect of the policies possible?
- Is there a regular update of data in the initiative considered and is data public available?

An overview of the main results of the analysis is provided, highlighting the methodological differences via a matrix that could be observed during the project.

In a third part a questionnaire based on the matrix information is applied to specific cities (Berlin, Madrid, Malmö, Milan, Ploiesti, Prague, Vienna and Dublin) to analyze in which way action plans vary.

Finally, the paper discusses these results and gives research and policy recommendations.

2 Compilation of different city projects

2.1 Covenant of Mayors (CoM)

2.1.1 Overview

One of the ambitious projects is the Covenant of Mayors (CoM) initiative. After 2008 when the EU climate and energy package was adopted the CoM was launched to support the implementation of sustainable energy policies by local authorities. The CoM has been voluntarily signed by more than 400 municipalities (local and regional authorities), which have, committed their own initiative, to the ambitious target of reducing CO_2 emissions and energy consumption in their cities beyond the 20% EU objectives by 2020. The share has to be increased by at least 20 % and the signatories commit to participating annually in the conference of European mayors for sustainable energy.

Besides the EU signatories (3699 signatories were published on the web in March 2012), cities from the United States, Argentina and New Zealand have expressed their interest in getting involved in the Covenant process.

With the signature municipalities have to adjust administrative structures, compile **emission inventories** based on the local energy consumption (as a base year it is recommended 1990) and prepare sustainable actions plans (**SEAPs**, 1189 SEAPs are published on the web in March 2012) in order to describe how the CO_2 emissions reduction will be reached. The project considers a wide range of information of local actions, **benchmarks** (relevant examples of local initiatives) on its webpage (http://www.eumayors.eu/about/covenant-of-mayors_en.html).

Signatories will have to submit a report evaluating results the state of implementation of actions every two years and emissions inventories every four years. Then cities will report to their citizens and to the Commission once every two years to monitor implementation. Having signed to the Covenant process the cities accept termination of their involvement in case of non-compliance.

The Commission gives support to the Covenant of Mayors Office (CoMO) and the Joint Research Center (JRC) to provide technical assistance for the preparation of action plans and to create and operate an office for co-ordination and networking of the cities.

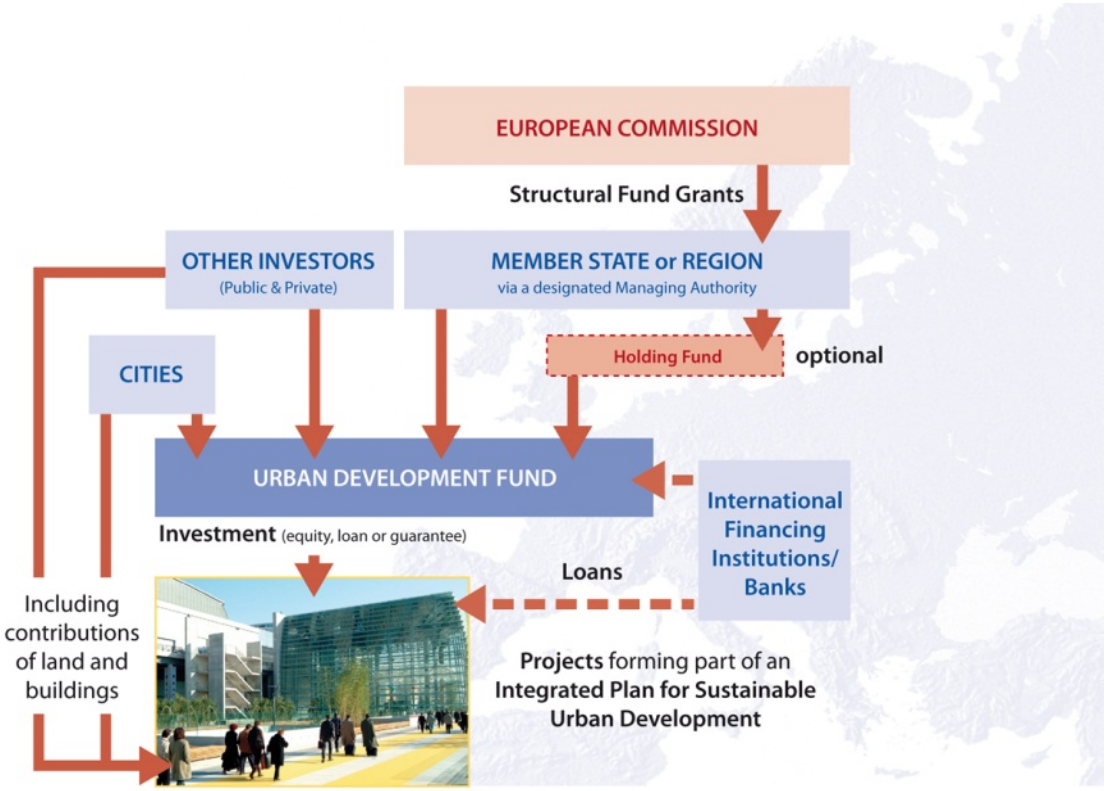
Concerning financing, an estimated 36 % of the total EU budget for the 2007 to 2013 period is allocated to the structural cohesion funds. Financial sources are available at local, regional and national levels, including from:

- local authorities' own resources,
- local partners' resources, and
- municipal and regional subsidies.
- Public-Private Partnerships

At EU level, the Covenant is also a well-organized institutional co-operation with the involvement of the Committee of the Regions, the European Parliament and the European

Investment Bank (EIB). In the last 5 years the EIB spent almost EUR 30 billion supporting urban transport and renewal projects.

Figure 2-1 'Jessica', Joint European Support for Sustainable Investment in City Areas



Source: European Investment Bank[3], 2012

The above figure (Figure 2-1) presents the structural management of the joint European support for sustainable investment in city areas (Jessica). Member States are given the option of using some of their EU grant funding, their so-called structural fund grants, to make repayable investments in projects forming part of an integrated plan for sustainable urban development. These investments are delivered to projects via urban development funds and, if required, holding funds.

The cost of local projects differs from one municipality to another and cannot be described in detail here. The costs are reported within the action plan but are not available to the public (see Figure 2-2).

[3] http://www.eib.org/products/technical_assistance/jessica/index.htm?lang=en

Figure 2-2 SEAP template for Sustainable Energy Action Plan

Title of your Sustainable Energy Action Plan

Date of formal approval | Authority approving the plan

Key elements of your Sustainable Energy Action Plan

Green cells are compulsory fields | Grey fields are non editable

SECTORS & fields of action	KEY actions/measures per field of action	Responsible department, person or company (in case of involvement of 3rd parties)	Implementation [start & end time]	Estimated costs per action/measure	Expected energy saving per measure [MWh/a]
BUILDINGS, EQUIPMENT / FACILITIES & INDUSTRIES:					
Municipal buildings, equipment/facilities	Action 1: _____ Action 2: _____ ...	1: _____ 2: _____ ...	1: _____ 2: _____ ...	1: _____ 2: _____ ...	1: __ 2: __ ...
Tertiary (non municipal) buildings, equipment/facilities					
Residential buildings					
Municipal public lighting					
Industries (excluding industries involved in the EU Emission trading scheme - ETS) & Small and Medium Sized Enterprises					
Other - please specify: _____					
TRANSPORT:					
Municipal fleet	Action 1: _____ Action 2: _____ ...	1: _____ 2: _____ ...	1: _____ 2: _____ ...	1: _____ 2: _____ ...	1: __ 2: __ ...
Public transport					
Private and commercial transport					
Other - please specify: _____					

Source: CoM, http://www.eumayors.eu/support/faq_en.html?id_faq=44, the figures presents partly the SEAP template

2.1.2 Emissions Inventories at local level

The comparison of baseline emission inventories from numerous municipalities is challenging. Although a SEAP guideline and reporting tables were developed the decision of which emission factors are used and the selection of the calculation tool which is applied depends on the compiler. There are two different kinds of emission factors: a) the use of emission factors of the IPCC guidebook or b) life cycle assessment, LCA, emission factors[4]. Thus, the results and the quality of estimated CO_2 emissions differ from SEAP to SEAP report. Other air pollutants or sources of noise are not considered in the inventory. The reports of the baseline emission inventory or time series are not available to the public. A database for the SEAP reports is developed by the Joint Research Center. In future the different emissions inventories will be analysed and discussed by the Joint Research Center for further reporting improvement.

[4] "The LCA emission factors include the actual emissions from all life cycle steps including final combustion, as mentioned earlier. This is of special relevance for biofuels: while the carbon stored in the biofuels themselves may be CO_2 neutral." Source: How to develop a sustainable action plan (SEAP) guidebook part 2, p. 11, European Union 2010

Regarding the signature and the respective SEAP report, the time series of CO_2 emissions can be presented from 1990 onwards (e.g. Energiekonzept 2020, Energie für Berlin, 2011, p. 2). Depending on the sectors transport, industry and residential sources (other sectors are not considered) the respective activity data (e.g. final energy consumption means fossil fuels in MWh and emissions in tons and CO_2 equivalent emissions tons) were reported with the reporting tables (see Figure 2-3). With the reporting of the SEAP, signatories are required at the same time to fill in the "SEAP template" in English.

Figure 2-3 SEAP template for Baseline Emission Inventory

Inventory year

For Covenant signatories who calculate their CO2 emissions per capita, please precise here the number of inhabitants during the inventory year:

Emission factors

Please tick the corresponding box:

☐ Standard emission factors in line with the IPCC principles

☐ LCA (Life Cycle Assessment) factors

Emission reporting unit

Please tick the corresponding box:

☐ CO2 emissions

☐ CO2 equivalent emissions

Kev results of the Baseline Emission Inventorv

Green cells are compulsory fields

Grey fields are non editable

A. Final energy consumption

Please note that for separating decimals dot [.] is used. No thousand separators are allowed.

Category	FINAL ENERGY CONSUMPTION [MWh]									
			Fossil fuels							
	Electricity	Heat/cold	Natural gas	Liquid gas	Heating Oil	Diesel	Gasoline	Lignite	Coal	Other fossil fuels
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES:										
Municipal buildings, equipment/facilities										
Tertiary (non municipal) buildings, equipment/facilities										
Residential buildings										
Municipal public lighting										
Industries (excluding industries involved in the EU Emission trading scheme - ETS)										
Subtotal buildings, equipments/facilities and industries										
TRANSPORT:										
Municipal fleet										
Public transport										
Private and commercial transport										
Subtotal transport										
Total										

Municipal purchases of certified green electricity (if any) [MWh]:	
CO2 emission factor for certified green electricity purchases (for LCA approach):	

Source: CoM, http://www.eumayors.eu/support/faq_en.html?id_faq=44, the figures presents partly the SEAP template

2.1.3 Information on policies and measures

The CoM initiative is mainly focused on the energy consumption, renewable and the reduction of CO_2 emissions. Co-benefits between AP and noise are not considered at all and a link of air emission inventories is not foreseen. The study does not assess the effectiveness of measures. Costs for the respective actions measure are reported per sector as well with the SEAP report of the municipalities. More than 1190 SEAPs have been reported since 2008 and the Joint Research Center analyses some of these reports to obtain an impression of the effectiveness of the CoM in the past and the ways in which improvements can be implemented, in particular in terms of the comparability of actions and emission inventories. The SEAP defines concrete reduction measures together with time frames and assigned

responsibilities which translate the long-term strategy into action. The SEAP must be uploaded in the national language (and/or in English) using the on-line submission facility.

A database tool (UBC Good Practices Database, http://www.ubcwheel.eu/) for good practice was developed from the Baltic Sea region entities and is published on the web. For local authorities it provides a list of practical examples of sustainable development in cities including all topics from transport to health and from social aspects to economic instruments complemented with suitable tools.

2.1.4 Project networking, results

The CoM is one of the interconnected initiatives and receives support for the sharing of information, organisation of meetings and further communication from the 'EUROCITIES' network between the local entities. Furthermore, the Covenant of Mayors Office (CoMO) is managed by a consortium of local and regional authority networks (e.g. Energy Cities, Climate Alliance and others). The local entities are honoured an annual Award for the best SEAP. A web-published newsletter provides information for the local entities (e.g. financing of projects) and of the local initiatives outstanding projects can be recognised as Benchmarks of Excellence. The main focus of the initiative is a sustainable energy and low carbon future.

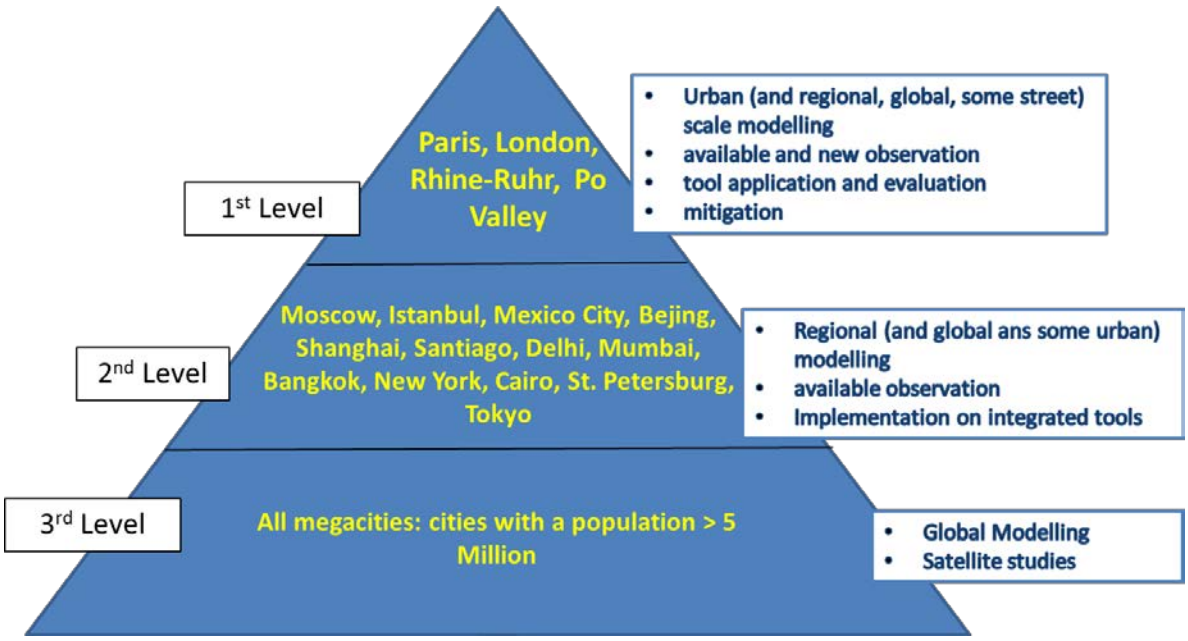
The most important result is without a doubt that despite the provision of the Guidebook, local inventories differ and comparability could not be assured. The data quality depends on the municipialities, their understanding and the information provided.

2.2 Megapoli

2.2.1 Overview

Megapoli (Megacities: Emissions, urban, regional and Global Atmospheric POLlution and climate effects, and Integrated tools for assessment and mitigation) started as a 3-year research (2008 – 2011) project and was funded by the European Commission through Framework Programme 7 (http://megapoli.dmi.dk/index.html). A cooperation of numerous European research groups of Member States and third countries was focused on spatial and temporal scales connecting local emissions (air quality, AQ) and weather (meteorology) with global atmospheric chemistry and climate. The concrete object of the project was to investigate and quantify interactions/impacts among megacities around the world, air quality and climate. Noise pollution or co-benefits with noise were not considered. The project focused in detail on the impacts of megacities and large air-pollution, should quantify feedbacks between megacity emissions, air quality, local and regional climate, and global climate change on a different spatial scale. Furthermore, integrated assessment tools for estimating the impacts of air pollution from megacities on regional and global air quality and climate were developed to evaluate the effectiveness of mitigation scenarios. The costs were about 5 million Euro in total for the project.

Figure 2-4 The pyramidal methodology in the project MEGAPOLI



Source: Megapoli[5], 2011

A three level approach for the integrated assessment was used in the project. Based on the third level (see Figure 2-4) all megacities under 5 million inhabitants were considered to investigate their effects on global air quality and climate. Global Chemical Transport Models (CTMs), Global Climate Models (GCMs) and satellite studies were also applied. For cities (Moscow, Istanbul, Mexico City, Beijing, Shanghai, Santiago, Delhi, Mumbai, Bangkok, New York, Cairo, St. Petersburg and Tokyo) in the second level a regional perspective was added to the global one. A combination of datasets (considering national and city emission inventories) with regional models (including selected urban scale model applications) was linked with integrated modelling tools. In the first level an urban and street scale perspective for some EU megacities was added to the regional and global ones.

2.2.2 Emissions inventories at local level

A European emission database for the substances NO_x, SO_2, NMVOC, CH_4, NH_3, CO and primary PM10 and PM2.5 for 2005 was developed by the Netherlands Organisation for Applied Scientific Research (TNO) (Kuehnen et al., 2010) and the primary datasets were available from the European Environmental Agency. The European emission inventory was based on national totals by source sectors (SNAP 97[6] 1st level) which were then distributed over a high resolution grid (1/8° longitude x 1/16° latitude, roughly 6x6 km) by using source sector specific spatial distribution proxies (e.g., population density for emission from residential combustion). For the European emission inventory officially submitted data from

[5] http://megapoli.dmi.dk/maininfo/megfoc.html
[6] Selected Nomenclature for Sources of Air Pollution, SNAP,

the Member States (UNFCCC[7] reporting, CLRTAP[8] reporting) were used. The data were in line with the reporting Guidelines of the IPCC[9] and UNECE[10] and followed the rules of TCCCA[11] (van der Gon et al., 2009). As a gap filled methodology, emission values had been considered to equal the last reported emission (e.g. 2004 or earlier) by the Member States.

The local megacity (Paris, London, the Rhine-Ruhr area, Germany, and the Po-valley, Italy) inventories were compiled by local agencies based on local statistics and activity data to estimate the emissions within their domain. Further information about applied emission factors, used methodology and quality was not published. Therefore, the comparability with other emission data is difficult. Both emission inventories are based on the bottom-up approach.

For Europe local bottom-up inventories emission estimates were compared to regional down-scaled European emission inventories. The estimates showed significant differences. In particular for the cities London and Paris the results have shown that for most pollutants the European down-scaled estimates were much larger than the local bottom-up estimates. The discrepancies were discussed and could be caused by the used distribution patterns, number of emission sources, which have a high uncertain emission factor (e.g. residential combustion of coal and wood) or certain emission sectors not being included in the respective emission inventory. An overview of the emissions per pollutant and per megacity and country of origin is presented in Table 2.1. Emission results were published for the cities and countries in the delivery reports D1.2 and D1.6 and published on the project webpage (http://megapoli.dmi.dk/index.html). The estimated datasets were completely available for the project partners.

[7] United Nation Framework Convention on Climate Change, UNFCCC
[8] Convention on Long-Range Transboundary Air Pollution, CLRTAP
[9] Intergovernmental Panel on Climate Change, IPCC
[10] United Nation Economic Commission for Europe, UNECE
[11] TCCCA, Transparency, Comparability, Consistency, Completeness, Accuracy

Table 2-1 Emissions of air pollutants in 2005 for the megacities and the totals for the countries in the final version of the MEGAPOLI European emissions map (tons/year)

	CH4	CO	NH3	NMVOC	NOx	PM_10	PM_2.5	SO2
Megacities								
Greater London	26001	88681	1415	61117	63162	2822	2691	1458
Ile de France	41652	250949	4994	123238	116919	18244	12484	26724
Rhine-Ruhr	59915	975111	18443	72609	274822	23520	17206	128688
Po Valles	1843804	1215479	264212	553251	505482	74652	58768	120503
Country Totals								
United Kingdom	2356548	2410973	317464	949708	1618823	150034	96291	705861
France	2680741	5642437	735638	1427850	1165667	503893	325765	449712
Germany	2295741	4032163	605005	1432331	1539261	209110	126950	560195
Italy	1905074	4207000	426012	1258214	1172968	165844	116089	496884

Source: Deliverable report 1.6, 2009, Tab. 3-1, p. 33

2.2.3 Information on policies and measures

The project linked emission inventories with an integrated assessment of AQ in megacities. Developed integrated assessment models could be coupled on mesoscale and microscale. Different abatement scenarios were applied to analyse the policy options which were effective in influencing the emissions of AP and GHG in megacities and how these options could be assessed. An overview of the results is given in the final summary report (A. Baklanov, 2011). As the main abatement instruments it was suggested:

- to replace solid fuels fired small combustion plants with efficient combustion techniques,
- to modernize old buildings in a more energy-efficient manor,
- to combine climate protection measures in the cement industry and
- to switch to renewable heat supply in the residential sector.

The outcome of the project was presented at the European Commission and should give support for new air pollution and climate change strategy and policies.

2.2.4 Project networking, results

The project and its results were presented on the official webpage. Meetings and milestones were announced and for inter alia communication a special registry was provided (MEGAPOLI Project final report, 2011). One outcome was that several European countries would not achieve the future threshold requirements of the Air Quality Directive (2008/50/EC) or the National Emission Ceilings (NEC) defined in the NEC directive (2001/81/EC), even with additional measures.

The main findings of the project can be described as:

- Quality and uncertainty of emission inventories
  The applied methodologies for emission inventories vary. While regional and national inventories often use national statistics and more general emission estimation methodologies (emission factors, activity data or proxies), local emission inventories use more detailed data (point source monitoring data, traffic counts, etc.) and implied

emission factors from measurements, but missing information could lead to higher uncertainty.

Pan European inventories, member states national top-down inventories, subnational regions and local bottom-up have to be compared and the integration work performed in MEGAPOLI should be updated periodically on a regular basis.

- Impacts/effects
  For further research the project findings identified the gap of knowledge regarding the mortality and morbidity of populations in megacities caused by poor air quality.

  It is proposed that the chain of models from emissions to air quality to exposure to health effects has to be investigated. The application of such integrated modeling chains would allow for the examination of cost-effective measures, policies and abatement strategies in order to ensure a sustainable development of megacities, including the health effects on the populations. For a better understanding of the interconnections between AP and CC and the improvement of emission factors more measurements campaigns on a local scale have to be conducted.

- Research needs
  The development and provision of so-called "shadow" scientific emission inventories are still needed for the implementation of new measures and to provide modellers with a consistent dataset across Europe to test the validity.
  A periodic intercomparison and integration of emission inventories carried out at different regional levels can improve the quality assurance of national inventories.

2.3 CityZen, mega CITY - Zoom for the Environment

2.3.1 Overview

The sophisticated CityZen project was a 3-year (2008 -2011) research project focusing on megacities and emission hot spots and was funded by the European Commission through Framework Programme 7. For Europe the emissions hot spots were the Benelux, Ruhr area and Po Valley. For case studies extreme weather conditions (summer 2003, & 2007) and feedbacks of air pollution and climate were investigated. 16 research institutions were involved and the cost was approx. four million Euro. The CityZen group worked together in joint activities within the Megapoli project. The CitiZen and Megapoli projects are among the WMO-GAW[12] Urban Research Meteorology Environment Project, GURME[13].

CityZen chiefly focused on the development of city emission data and scenarios, ground-based measurements and satellite measurements (observations) for CH_4 and CO_2 (greenhouse gases) and AQ substances (e.g. NO_2, SO_2, HCHO, and CHOCHO) on a medium-scale. In particular, the

[12] WMO: World Meteorological Organisation, GAW: Global Atmosphere Watch
[13] GURME: GAW Urban Research Meteorology and Environment Project. The project aim is the evaluation of model performance to make an international common understanding and improve air pollution modeling in East Asia. Therefore, it is not relevant for this overview.

influence of megacities on climate change and climate forcing were estimated. Similar to Megapoli, the project estimated scenarios up to 2030 and mitigation options should give policy feedback (https://wiki.met.no/cityzen/).

2.3.2 Emissions inventories at local level

'Emissions' (air quality data were mentioned) for Europe were provided by the Institut National de l'Environnement Industriel et des Risques (INERIS). By combining satellite data with atmospheric models, emission estimates were made from the observations, so that the results of the project could underpin the clean air measures taken in the past, such as the EU Air Quality Directives, and provide information on the accuracy of emission estimates based on statistical data reported to environmental agencies. The data are not available to the public (see Gauss et al., 2011).

Furthermore, the UNECE/EMEP emission inventory (CLRTAP reporting of the MS) was used in consideration of the 1998-2007 period for modelling air quality over Europe with several state-of-the-art chemistry transport models (CTM) using the same emission inventory (Granier. C, 2010). Therefore, it can be assumed that the UNECE/ EMEP and IPCC reporting guidelines were applied and all emission source relevant sectors (SNAP) were used. The emissions are provided for the following species: carbon monoxide (CO), nitrogen oxides (NOx), sulphur dioxide (SO_2), total non-methane volatile organic compounds (NMVOCs), ammonia (NH_3) and particulate matter (PM2.5 and PM10).

A global anthropogenic emissions dataset covering the period 1997-2000 was developed for the CITYZEN project by the CNRS group.

As mentioned in the report the dataset has been constructed from two datasets: a new global inventory which has been developed in the framework of the Intergovernmental Panel on Climate Change (IPCC) Assessment Report 5 (AR5), as well as the regional inventory for Europe described above. The emissions are provided by EMEP at a 0.5x0.5 degree resolution and have been regridded at a 0.1x0.1 degree resolution in latitude and longitude, using the fine scale global land cover database GlobCover (http://ionia1.esrin.esa.int). The emissions are given as an annual total per grid cell (in Mg/cell), and for different emissions sectors. By linear interpolation of the IPCC emissions in 1990 and 2000 the anthropogenic emissions for the years 1997-2000 were obtained. Furthermore, the results were compared with other global or regional emission inventories.

2.3.3 Information on policies and measures

On the project webpage (https://wiki.met.no/cityzen/policy_brief) statements about the ozone, particulate matter (PM), observations and a focus on the situation on the East Mediterranean region were published. The main results of the project were that:

- the ozone will be influenced in the troposphere and at ground-level by climate change, human actions, and changes in the biosphere during the next few decades.

- with the results of PM10 monitoring observation stations it could be verified that PM10 concentrations in Germany, UK, and BeNeLux had been decreasing (1998-2007). This can be linked with successful air quality regulation. More observation sites would underpin data and information and predictive capabilities. Long-term

monitoring of PM2.5 should be increased for getting a complete picture of impacts and vulnerability.

- air quality networks are still important for pollution observations. Satellite observations already provide useful information on pollutant distributions and patterns on regional scales. As resolution in space and time improve further, integration of satellite data into pollution observation strategies becomes increasingly important, but the interpretation of the results is difficult.

- regional conditions should be taken into account more when developing air pollution control strategies, considering the influence of natural sources and long-range transport. For the East Mediterranean air quality it will require a coordinated effort among the countries in the region and beyond. Therefore, the focus of the legislation should be pursued in a regional strategy for air quality and climate change mitigation to achieve improvements in air quality.

2.3.4 Project networking, results

With its webpage the project is still presented in the web and publication or results can be downloaded. Communication between the project partners was given via announcement of meetings and publication of reports and scientific literature.

One main result was that megacity areas exhibit large differences in their per capita sectoral emission production leading to very particular emission patterns for each megacity.

There are differences in the per capita sectoral emission production in cities which lead to very particular emission patterns for each megacity. In recent years monitoring sites in cities have been reduced and thus significant gaps in data and information have arisen, limiting effective model evaluation and predictive capabilities. Emission reduction measures proved to be efficient for ozone precursors and should be continued.

2.4 Soot free cities campaign

2.4.1 Overview

The ‘Soot free cities’ campaign was initiated and conducted by the German environmental and consumer associations (http://sootfreecities.eu/). It was carried out by ‘Friends of the Earth Germany’ in cooperation with the European Environmental Bureau and started to address the climatic effect of black carbon (soot) in March 2009. The campaign is still running. The co-benefits of AQ and live expectancy should be examined. The goal of the campaign is the reduction of BC emissions in the local transport sector (in particular for diesel fuel). This campaign is focused on the European Union and by conducting a city ranking best practices of local air abatement measures were compared and assessed in terms of which of the 17 selected cities made most use of them.

2.4.2 Emissions inventories at local level

Reported reductions of local PM10 emissions were evaluated for the period between 2005 and 2009. Over 20 municipalities received a detailed questionnaire. With the feedback of 14 cities and public information on three other cities a city ranking could be developed. If cities

did not reply to the questionnaire, information was taken from the internet, action plans and non-governmental organizations (NGOs) to fill gaps. The questionnaire considered nine categories of measures which have a high potential to reduce particulate matter (PM10). BC is not in the air quality measurements campaigns considered.

The categories could be split into the results of reduction success and information and participation.

1. Reduction success: urban traffic stations minus regional background stations,

Three categories focus on technical reduction measures

2. Low emission zones, bans of heavy emitters (i.e. heavy goods vehicles),
3. Public procurement / cleaner fleets,
4. Non-Road Mobile Machinery (NRMM)

5. Economic instruments (Congestion Charge, Parking Management, subsidies, etc.)

And sustainable transport measures:
6. Traffic and mobility management (modal split as background information)
7. Promotion of public transport
8. Promotion of cycling and walking
9. Transparency and communication

The 'Transparency & Communication Policy' topic on the webpage is linked with information on the air quality of the local entity. Therefore, measurement results are linked. But there is no publication of the initiative available, which gives an overview of the local data itself.

Under the 'Reduction Success in Local Emissions' topic the number of days exceeding the PM10 limit in 2005 with the latest reported data for 2009 were evaluated. A comparison of the measurements at traffic stations and background stations was conducted in order to better understand the role played by local traffic for both years. The data was collected from AirBase, the public air quality database system of the European Environmental Agency (EEA). In some cases, the data appeared inconsistent or incomplete, which resulted in a lower grading.

As mentioned in the report the methodology for analysing and evaluating the cities' responses was based on the same method used by BUND for their two German city rankings. A table was developed with marks given for each of the main categories from the questionnaire. The evaluation of the measures followed a specific ranking system: for every city by giving five grades ++, +, 0, -, -- and translated the results with 5, 4, 3, 2, 1 points. The number of points was converted into the a grading system from A (100-90%), B (89-80%), C (79-70%) D (69-60%) and F (under 59%, failed). The methodology has an empirical approach.

In comparison with the Megapoli and CityZen projects this campaign does not provide a scientific assessment of the reduction potential of the different measures.

2.4.3 Information on policies and measures

The initiative will give support to local policy makers to motivate more and more cities and local entities to reduce their BC emissions and implement potential emission abatement strategies. Technical fact sheets with background information on investment costs, emissions and strategies are published. The main focus is to reduce BC which also has a global warming potential and harms health as an air pollutant. Co-benefits with other pollutants or GHG are not mentioned in this initiative, but the reduction of BC emission is linked with climate, climate change and air quality.

The ranking of the cities is presented via an interactive webpage. The main message of the initiative is that the EU air quality policy must be regularly adapted to the continuing development of technology, and pollutant limit values are to be dynamically tightened accordingly until the time when no environmental pollution is produced.

2.4.4 Project networking, results

The project and its results were presented on the official webpage. Meetings and activities were announced.

As a result it could be described that many local solutions exist which improve air quality and the ways in which the cities use these solutions. A combination of approaches for each individual city has to be taken into account: technical air quality measures (on cars, lorries, construction machinery, buses, trains, etc.) and measures to reduce individual motorised transport by increasing improvements of cycling and public transport. Furthermore, environmental zones, which lead to a modernisation of vehicle fleets, are the most effective single measure (Quitta, A. et al., 2012, p. 33). Therefore, every city has to develop its own action plan and consistently implement it.

The ranking mainly focused on efforts made to reduce particulate matter (PM10) and soot, or black carbon.

2.5 European Green City Index

2.5.1 Overview

The research project was conducted by the company Siemens. The aim of the project was to assess the environmental impact of Europe's major cities. The methodology was developed by the Economist Intelligence Unit in cooperation with Siemens in 2009 (http://www.siemens.com/entry/cc/en/greencityindex.htm) to today. Feedback and information on the methodology were given by local authorities. The European Green City Index represents the environmental performance of all 30 European capital cities. No information is given on the cost of the study or per city. To realize the index the cities were scored across the eight following categories:

- CO_2 emissions,
- energy,
- buildings,
- transport,
- water,

- waste and land use,
- air quality and environmental governance.

Furthermore, 30 individual indicators (environmental areas, from environmental governance and water consumption to waste management and greenhouse gas emissions) per city were taken into account. Similar to the methodology of the 'Sootfree cities campaign' qualitative indicators were ranked on a scale of 0 to 10, with 10 points assigned to cities that met or exceeded the check-list of criteria. In the case of the "CO_2 reduction strategy" indicator, for example, cities were assessed according to the implementation strategies and realisation of the abatement policies.

2.5.2 Emissions inventories at local level

In general, data had been used from official sources like national statistical offices and national environmental bureaus. In most cases data cover the year 2007 (European Green City Index, 2010), which was the most recent year available for the following indicators:

- Total energy consumption from buildings
- Total fuel consumption from fleet
- Total miles driven from fleet
- Average fleet fuel efficiency
- Total airline miles traveled
- Total CO_2 relative to total revenue
- Fleet CO_2 relative to service revenue.

Where gaps in the data existed, the Economist Intelligence Unit produced estimates from national averages. The study pointed out that one-third of the 30 cities did not measure the full amount of energy consumed and therefore associated CO_2 and air pollutants (NO_x, SO_2, O_3, PM10, SOx) emissions are underestimated in the city. In most cases, the cities calculate only how much energy is consumed from electricity, gas and district heating. To calculate associated CO_2 emissions for the city national CO_2 emissions factors associated with the combustion of each energy source were used and quantified. For the other air pollutants the annual daily mean of specific emissions was used.

2.5.3 Information on policies and measures

Furthermore, the assessment of the extensiveness of policies to improve air quality or CO_2 emissions reduction strategy of each city was considered in the ranking and to present the benefits at least in the report. However, co-benefits of CC and AP in detail were not underlined. But indeed if in the sector transport or energy CO_2 emissions reductions per facility or point source have been considered a decrease of AP emissions can be expected as well.

2.5.4 Project networking, results

In comparison with the other initiatives or projects an interaction of communication was not one of the main goals for this project. Therefore, a forum via internet is not presented.

For the German company Siemens sustainability and environmental protection is one of the marketing items and have to be taken into account for the environmental portfolio of Siemens where technical products and solutions (e.g. facilities, heating, smart solutions for insulation of buildings etc.) for environmental and climate protection can be sold and launched.

Certainly, one of the major key findings of the study is that wealth (GDP per capita vs. European city index score) and environmental performance significantly positively correlates. Therefore, it is not astonishing that the Nordic cities dominate the top ten of the index. Copenhagen is at the top of the index overall and in comparison with the 'Soot free cities campaign' the ranking of the cities are similar for the Nordic capitals.

Furthermore, the message of sustainability and green environment intended to ensure that all inhabitants in particular in big cities contribute with their behaviour and consumption to their own ambience and health.

2.6 Common Information to European Air, CiteAir

2.6.1 Overview

CITEAIR supported European cities and regions in their efforts to meet limit values and improve the air quality for their citizens. During 2008 to 2011, the CITEAIR II (Common Information to European Air, http://www.citeair.eu/) project was co-funded under the European Commission INTERREG IVC program. 11 European institutions are involved; the focus is on 90 cities in Europe. No information was provided on the budget.

The project based on the experience and users of the previous CITEAIR (http://citeair.rec.org/home.html) project (2004-2007, INTERREG IIIC) which air quality indices has implemented on the European level. Furthermore, the main aim of the previous project was to develop better and more efficient solutions (tools) for assessing the impact of traffic on air quality in large urban areas and to give guidance on efficient measures to abate adverse environmental situations. The following tools were developed:

- A tool to compare the air quality in European cities;
- A tool to benchmark the emissions from mobility modes;
- A tool to integrate greenhouse gases emissions into existing air quality assessment schemes;
- A tool to forecast air quality.

As a follow-up project, the new aim of CITEAIR II was to analyse and transfer a set of good practices and to improve the effectiveness of regional development policies in the area of air quality protection, sustainable transport and reduction of greenhouse gas emissions. The results and generated indices for the cities of CITEAIR are implemented on an interactive web service accessible at www.airqualitynow.eu. It provides a platform to compare past, current and future air pollution situation in different cities in an easy to understand.

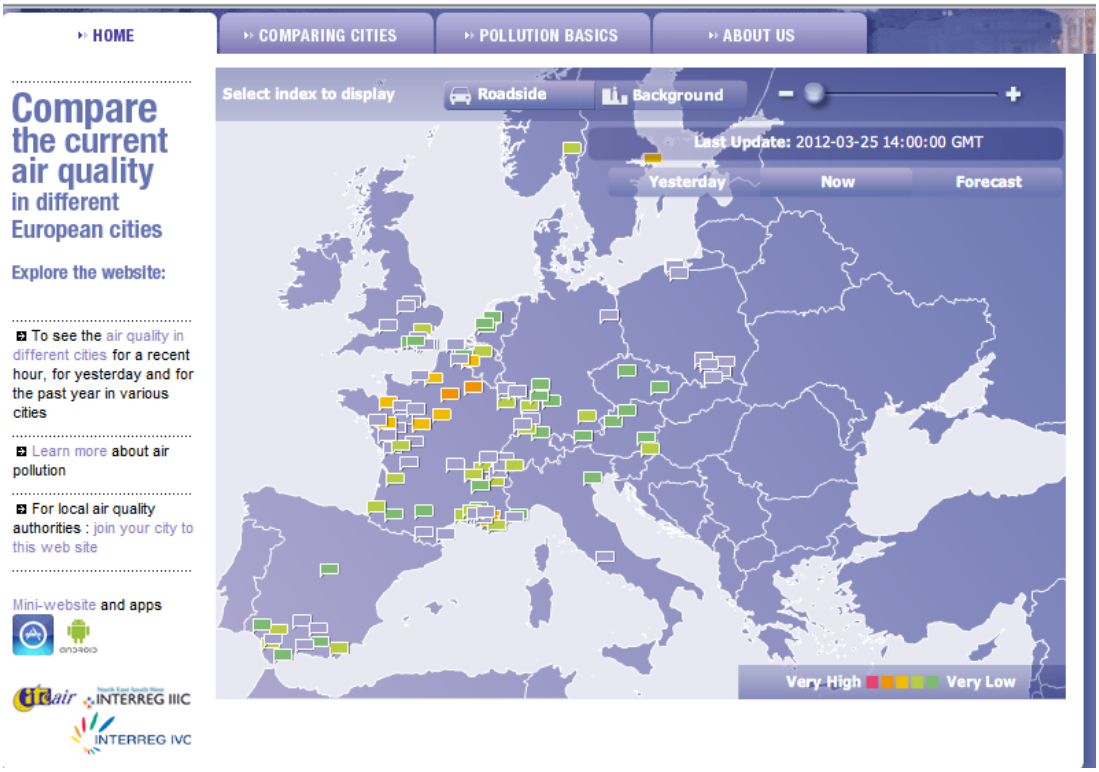
2.6.2 Emissions inventories at local level

One task of the project was to develop an integrated emissions inventory database for CO_2, PM 10, NO_x and NO_2 considering different sectors according the IPCC Guidelines 2006 and

applying different scenarios. The idea was to offer a tool for cities to create their own emission inventory based on the UNECE database 'CollectER' and to combine air and climate emissions into a single system. The developed guidebook elaborates guidelines on how to develop baseline information to formulate and monitor climate change and air quality programs in a consistent way (http://www.citeair.eu/index.php?id=10). As it is written in the guidebook (p.17) the uncertainty of the calculated emissions could be quite high on local level.

The proposed indices are presented on the common webpage at www.airqualitynow.eu and are designed to give a dynamic picture of the air quality situation in each city (see Figure 2-5).

Figure 2-5: Tool for visualisation of air quality indices on the official webpage



Source: http://www.airqualitynow.eu/, 2012

Another task was to present the air quality situation in European cities in an easy way, that all detailed measurements are transformed into a single relative figure: the Common Air Quality Index (CAQI).
The hourly index describes the air quality today, based on hourly air quality measurements and is updated every hour.
For the indices five levels were indicated using a scale from 0 (very low) to > 100 (very high). The calculation of the index is based on a review of a number of existing air quality indices, and it reflects EU alert threshold levels or daily limit values as much as possible.
Like the hourly and daily index, the Year Average Common Air Quality Index (YACAQI) was calculated for traffic and city background sites.

2.6.3 Information on policies and measures

The webpages present all the legal and scientific background information on policies and measures. In contrast to the 'Soot free cities campaign' suggestions of implementation strategies are not given but the air quality status of cities and integrated urban emission inventories (see http://www.citeair.eu/index.php?id=10) via an interactive map on website (http://www.airqualitynow.eu/) should give local authorities an impression of how they can interact. Furthermore, local emission inventories considering AP and CO_2 could also be prepared.

2.6.4 Project networking, results

The project results are still available on the webpage and publication or results can be downloaded.
With the guide (Communicating Air Quality) practical examples for communicating with the public and a proposal for a City Annual Air Quality Reports, which is a common reporting format, and a semi-automatic report generator could be developed. Furthermore, assistance in air quality management to identify tools and measure to improve air quality could be given to cities. With the help of the database CollectER data could be used for air quality modelling, giving detailed AQ information; in addition local knowledge is made available through the inventory. Furthermore, emissions forecasts based on industrial activity can be made and benchmarking across a sector of industry is possible. Applying varying EFs scenarios could be offered that reflect technology-driven improvements (such as modernizing the mobile sources and the logistical techniques).

2.7 METREX - The Network of European Metropolitan Regions and Areas

The METREX network (the Network of European Metropolitan Regions and Areas) started in 1996 with the support of the European Commission (METREX Manual, 2011). It facilitates a platform for the exchange of knowledge on metropolitan affairs and joint action on issues of common interest (http://www.eurometrex.org/).

Around 50 metropolitan regions and areas and partners are members in the network and cooperate together. METREX supports policies, programs and projects on a European scale. The Network works as a partner of European institutions, the research community, governmental organisation and other networks. In general, the network is self-funded and meetings are paid by delegate fees. Information on policies and measures are not in the main focus of the network. The different subprojects take this into account.

METREX itself does not measure or compile any pollution or GHG information. There is a range of key inter-related social, economic and environmental issues that are addressed in five sub projects of METREX. Two of these projects, which focus on more environmental issues, are discussed here in detail. Reports for the main activities and background information of the different projects are available online.

2.8 InterMETREXplus Project

2.8.1 Overview

InterMETREXplus was the successor project of the first InterMETREX project which was mainly used for metropolitan spatial planning practice under the management of METREX coordinating the work between research institutions and city entities. As an additional component climate change was taken into consideration.

Starting with four pilot partners the application of the Greenhouse Gas Regional Inventory Project (GRIP) model at the metropolitan level was applied. GRIP was conceived and developed through the Tyndall Centre (UK) for climate change research. InterMETREXplus was funded (budget around 1.16 Mio €) by the INTERREG IVC Operational Program[14] which was published by the European Commission in April 2007. The aims of the InterMETREXPlus[15] project extension were:

1. to develop the GRIP GHG inventory methodology in a user friendly tool which could be applied to all the pilot regions, and

2. to test the GRIP scenario tool at the metropolitan regional scale (Glasgow and the Clyde Valley).

2.8.2 Emissions inventories at local level

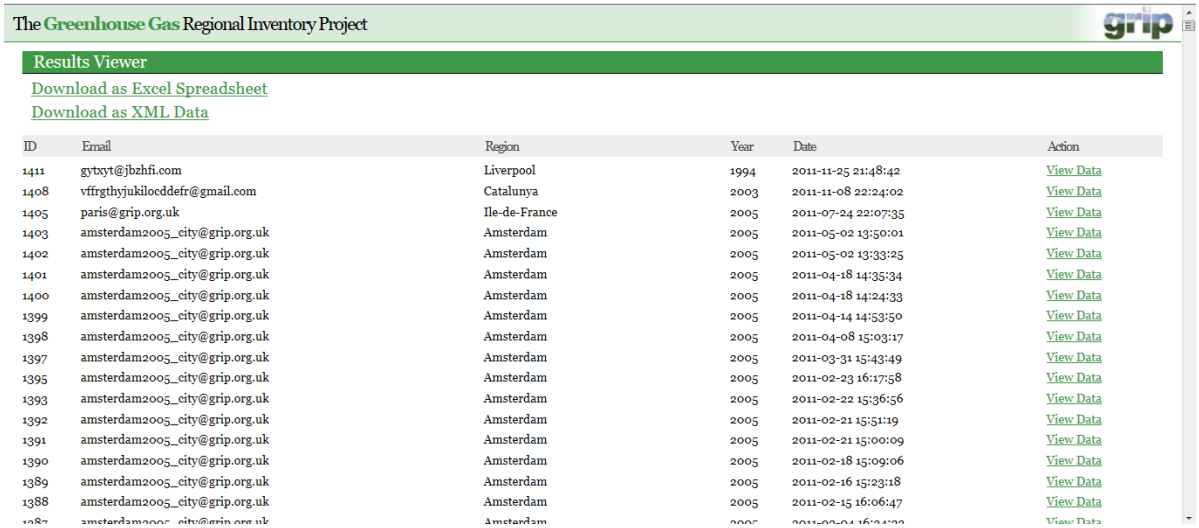
The emission inventory tool (see Figure 2-6) is an online web application (http://www.carboncaptured.org.uk/) which takes demographic and economic data into account. The inventory methodology utilises a mix of data sets to form an activity and emissions output. These may be either directly measured or based upon an estimated value (see Carnier, S., 2008).

The methodology is similar to the IPCC applied one (sectors and uncertainty description) but differs in the used data sets at the spatial level: regional energy consumption and supply statistics, the respective country's national inventory, regional agricultural statistics, regional waste disposal. The data are available for an inventory year (e.g. only 2005) but not presented as a time series. The GRIP methodology was evaluated in 2009 by the Joint Research Centre of the EU (European Union, 2010) and subsequently recommended by the Covenant of Mayors (CoM).

[14] The aim of the INTERREG IVC program was to improve, by means of interregional cooperation, the effectiveness of regional development policies in the areas of innovation, the knowledge economy, the environment and risk prevention as well as to contribute to economic modernisation and increased competitiveness of Europe (see EUCO2 80/50 Outline Prospectus, Appendix 2).

[15] (http://www.eurometrex.org/ENT1/EN/Activities/activities.asp?SubCat1=InterMETREXplus)

Figure 2-6 The Greenhouse Gas Regional Inventory Project (GRIP) Result Viewer



ID	Email	Region	Year	Date	Action
1411	gytxyt@jbzhfi.com	Liverpool	1994	2011-11-25 21:48:42	View Data
1408	vffrgthyjukilocddefr@gmail.com	Catalunya	2003	2011-11-08 22:24:02	View Data
1405	paris@grip.org.uk	Ile-de-France	2005	2011-07-24 22:07:35	View Data
1403	amsterdam2005_city@grip.org.uk	Amsterdam	2005	2011-05-02 13:50:01	View Data
1402	amsterdam2005_city@grip.org.uk	Amsterdam	2005	2011-05-02 13:33:25	View Data
1401	amsterdam2005_city@grip.org.uk	Amsterdam	2005	2011-04-18 14:35:34	View Data
1400	amsterdam2005_city@grip.org.uk	Amsterdam	2005	2011-04-18 14:24:33	View Data
1399	amsterdam2005_city@grip.org.uk	Amsterdam	2005	2011-04-14 14:53:50	View Data
1398	amsterdam2005_city@grip.org.uk	Amsterdam	2005	2011-04-08 15:03:17	View Data
1397	amsterdam2005_city@grip.org.uk	Amsterdam	2005	2011-03-31 15:43:49	View Data
1395	amsterdam2005_city@grip.org.uk	Amsterdam	2005	2011-02-23 16:17:58	View Data
1393	amsterdam2005_city@grip.org.uk	Amsterdam	2005	2011-02-22 15:36:56	View Data
1392	amsterdam2005_city@grip.org.uk	Amsterdam	2005	2011-02-21 15:51:19	View Data
1391	amsterdam2005_city@grip.org.uk	Amsterdam	2005	2011-02-21 15:00:09	View Data
1390	amsterdam2005_city@grip.org.uk	Amsterdam	2005	2011-02-18 15:09:06	View Data
1389	amsterdam2005_city@grip.org.uk	Amsterdam	2005	2011-02-16 15:23:18	View Data
1388	amsterdam2005_city@grip.org.uk	Amsterdam	2005	2011-02-15 16:06:47	View Data

Source: GRIP, 2012, http://www.carboncaptured.org.uk/results/

2.8.3 Information on policies and measures

With the presentation and comparison of the results per region and sector including statistical data, the consumption per capita is evident (see Table 2-2). Thus, mitigation strategies can be directly developed per sector (see InterMETREX Project Extension, 2007).

Table 2-2 Domestic fuel consumption and emissions the four regions

	Glasgow		Stockholm		Bologna		Veneto	
Fuel	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2	Consumption (GWh)	Kt CO_2
Electricity & Heat	4060	1896	11833	512	1185	443	5175	1937
Gas	12766	2397	77	4.6	7667	1537	39533	7927
Solid	377	106	0	0	2	0.7	8	3
Liquid	990	267	2558	682	515	284	2855	727
Total	18193	4666	14468	1198	9369	2265	47571	10594
Household	786786		880000		455100		1852900	
Per Household	23	5.93	16.44	1.36	20.6	4.9	25.6	5.7
Population	1747000		1900000		915000		4700000	
Per Capita	10.4	2.67	7.65	0.63	10.23	2.47	10.12	2.3

Source: InterMETREXplus Project Extension, 2007

2.8.4 Project networking, results

The results and the project are presented via the network platform METREX.

With the online tool regions can compare their own energy consumption and CO_2 emissions per capita. The metropolitan spatial planning practice could be linked with information about mitigation potentials so that the respective emission source can be directly evaluated for

reducing GHG emissions (e.g. reducing the need to travel and increasing opportunities to use low carbon energy).

2.9 EUCO$_2$ 80/50 Project

2.9.1 Overview

The EUCO2 80/50 project was initiated in 2007/2008 and the Metropolregion Hamburg took over the leadership (http://www.eurometrex.org/euco2/EUCO2_docs.htm) (project duration 2008 – 2010, further steps until 2012 were conducted). The project applied the Greenhouse Gas (GHG) Regional Inventory Protocol (GRIP) (see Metropolitan Mitigation Measures Sourcebook, 2011, Regional Inventory Brochure and Outline Prospectus Brochure) using the methodology which was developed by the InterMETREX plus project considering more cities and regions. The main aim of the project was to examine in what ways and which region the target for Europe (to meet an 80% reduction in emissions) could be realized up to 2050. The project is divided in the following steps:

1. Compilation of regional energy data;
2. Simulation of GHG reduction scenarios with the GRIP model;
3. Conducting strategy workshops with participation of regional stakeholders where specific strategies should be proposed to the political, economic and social decision makers at the end of the GRIP process.

2.9.2 Emissions inventories at local level

GHG emissions inventories and energy baselines were formed for the partner region with the GRIP inventory methodology. Therefore, from 2008 until 2010, CO_2 emissions and energy data for 18 cities and 3 regions were compiled and finally used in a series of regional scenario workshops. For mitigation scenarios and selecting mitigation strategies the year 2050 was considered and the emissions inventories used the baseline year of 2005. The inventory covered the six GHGs which were estimated for each key sector in each partner region. The data can be uploaded per year but there is no time series visualised.

2.9.3 Information on policies and measures

Applying different scenarios the project results could identify abatement strategies up to 2050. These support the EU in devising specific and long-term binding regulations and funding criteria on the subject of climate change considering regional circumstances (EU CO2 80/50 outline prospectus, 2010).

- Low Carbon Electricity generation: With the energy shift towards from fossil fuels to a higher amount of renewable sources the production of electricity will become a low carbon intensive one.

- Emissions reductions in the building: In the residential and the service sectors, demand reduction measures such as insulation together with low carbon fuels can deliver high CO2 emissions reductions.

- Increased industrial efficiency can contribute substantially to emissions reductions if their energy consumption per unit of output can be reduced.

- Road transport: Emissions reductions were realised through efficiency improvements and fuel switching to electro-mobility, hydrogen and bioenergy.

But at the end of the project only 35% of the scenarios achieved the target of an 80% reduction. Furthermore, given as a regional result, southern European stakeholders were less confident of their ability to mitigate emissions than the rest of Europe.

2.9.4 Project networking, results

The results and the project are presented via the network platform METREX.

On the webpage http://www.euco2.org/ different EUCO2 Pilot Project of city partners (Bologna, Stockholm, Veneto, Glasgow) and case studies are published. As an example: with the cooperation of the local entity in Hamburg (Senat of Hamburg) an extra funding of 25 Mio€ was launched to implement the Hamburg Climate Action Plan from 2008 to 2012.

2.10 Climate Cities Benchmark (CCB)

2.10.1 Overview

In the framework of a research project of the German Federal Agency for Environment and together with 'Climate Alliance' (European network of local authorities committed to the protection of the world's climate) the IFEU Institute developed in the year 2009 the Climate Cities Benchmark (CCB) (Klimaschutz in Kommunen, 2011). The aim of the CCB is to analyse and balance CO_2 emissions, comparing climate city activities for better understanding of onsite mitigation potentials.

The internet-based monitoring tool support local authorities analysing sustainable energy policies and climate action for their region. This tool is currently only available in Germany. The results of the benchmarking can be incorporated in local climate action (see http://www.climate-cities-benchmark.net/).

The CCB considers four elements: a city fact sheet, an activity profile, CO_2 emission time series from 1991 – 2005 (later 2009) and a set of indicators (e.g. CO_2 emissions per capita, transport, energy consumption etc.), which underline the items in which the city has achieved significant progress and which actions should be enforced (see http://www.klimabuendnis.org/benchmark1.html?&L=2).

With the activity profiles the state of climate protection activities within the city can be visualised by 26 action fields in the following categories: climate policy, energy, transport and waste.

2.10.2 Emissions inventories at local level

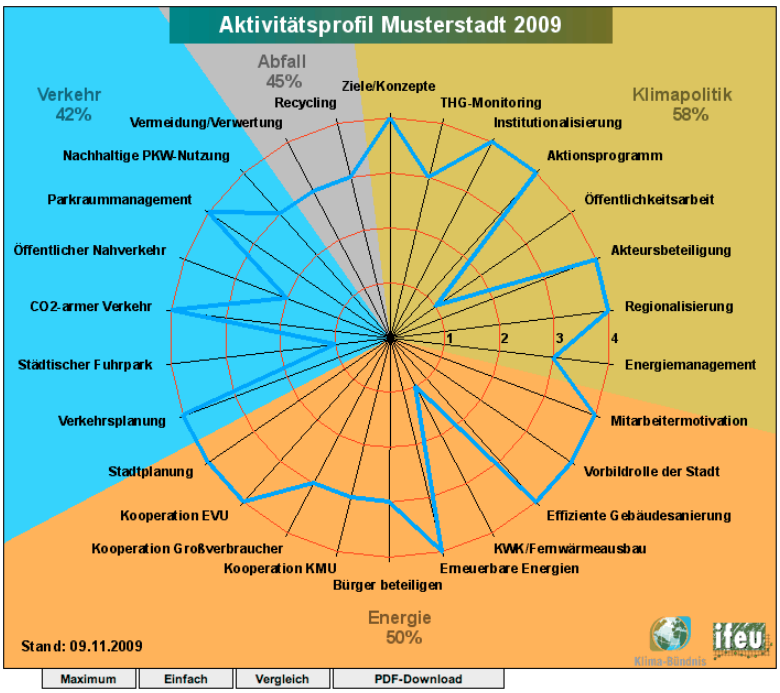
The CO_2 emission inventory tool ECORegion tool uses the bottom-up approach and was developed by the Swiss company Ecospeed in cooperation with Climate Alliance and other partners. Within the scope of establishing the database the Climate Alliance developed a set of rules for monitoring local CO_2 emissions which are in line with the IPCC and Covenant of Mayor guidelines. The database considers energy, emissions and further environmental

factors which are updated each year, and lists the time series. In the beginning the local inventory data on the number of inhabitants and of employees are needed to develop a comprehensive final inventory. The export of relevant inventory data to the baseline emission inventory of the SEAP template is possible. The local authorities get access following online registration.

2.10.3 Information on policies and measures

With the online presentation of the Climate Alliance information on actual policy, projects and measures is given to the public (http://www.klimabuendnis.org/home.html?&L=0). Currently, any information on policies and measures is given on the project webpage 'climate cities benchmark' and any information on co-benefits between AP and CC and noise as a pollutant is given. However, with the tool ECOregion activity profiles (see Figure 2-8) can be visualized which indicate further local policy and measures.

Figure 2-7 Activity profile from the tool ECOregion



Source: Climate Cities Benchmark, 2012, http://www.klimabuendnis.org/benchmark1.html?&L=2

2.10.4 Project networking, results

The climate cities benchmark is presented and programs, events and presentation are published on the webpage of the Climate Alliance. Communication between members is possible following registration (only possible on the German webpage). The Climate Alliance webpage also provides publications which can be downloaded and registered members can access a specific forum.

Any results or information (a comparison of different cities' CO_2 emission inventories is lacking) on the cities which uses Ecospeed are presented. One main outcome was that activity

profiles per communities which showed the status and degree of implementation of mitigation measures in the four priority areas of climate policy, energy, transport and waste management could be developed. By applying specific indicators, the effects of the urban climate protection efforts can be assessed.

2.11 Fairmode Initiative

2.11.1 Overview

In 2008 the Forum for Air Quality Modelling was initiated as a cooperation between the European Environment Agency (EEA) and the European Commission Joint Research Centre (JRC) to bring together air quality modellers and users referring to the European Air Quality Directive (FAIRMODE, http://fairmode.ew.eea.europa.eu/). Co-partners were researchers of the Norwegian Institute for Air Research – NILU and of the Aristotle University Thessaloniki – AUTH. The important objectives of the Forum for Air Quality Modelling (FAIRMODE) were:

- to establish harmonised tools and methodology for enhancing communication between modellers and model users;
- to provide a centralised portal for information concerning air quality modelling;
- to establish a common infrastructure based on best practice for reporting and storing the information;
- to promote model validation and quality assurance of model results (deloping guidance and recommendations) to identify limitations and
- to support the revision of the Air Quality Directive (AQD).

The forum is divided into two working groups and sub groups which work on a guidance document for the application of air quality models (lead by the EEA) and on quality issues (led by the JRC).

2.11.2 Emissions inventories at local level

An emission inventory was not developed but the sub-group (SG3) on urban emissions and projections information was focused mainly on the analysis of national reported emissions or air quality parameters. For scientific research the sub-group was established with the aim to improve and validate modelling tools (e.g. the Delta tool) on which decision-making could be based. All air pollutants of the Air Quality Directive are considered. A compilation of emission inventories of the Member States under the respective directive (National Emission Ceiling, Convention on Long-range Transboundaries, Pollutant Release Transfer Register, Large Combustion Plant Directive) is published and meta-information (information on networks, stations and measurement configurations) and statistics for all years are available in database systems (see http://acm.eionet.europa.eu/databases/airbase/query_retrieval.html or http://fairmode.ew.eea.europa.eu/fol065026/data-archives). Data can be downloaded per country, pollutant (component) and year. Emission information is reviewed by external

review teams according the respective guidance documents of the directives considering the most relevant emission sources.

A technical EEA reference guide (http://www.eea.europa.eu/publications/fairmode) for the application of models under the European Union's Air Quality Directive provides a general overview of the use of models:

- Ambient air quality, pollutant dispersion and transport models
- Good Practice Guide for Atmospheric Dispersion Modelling
- Guideline on Air Quality Models - Appendix W to Part 51
- Meteorological Monitoring Guide - WebMET

Furthermore, on the basis of Environmental Impact Assessment (EIA) the environmental consequences of a proposed project/activity can be predicted in a formal study process, applying existing EU and national legislation and methods (see http://aix.meng.auth.gr/AIR-EIA/info.html). In the 'Guidance document for modelling' it is stated (p.47) that independent checks of emission inventories need to be made with the help of a form of inverse modelling method, keeping in mind that the quality of the emissions estimate using inverse modelling will not only depend on the quality of the model used but also on how well conditioned (i.e. how many similar solutions are possible) the inverse problem is.

A guidance which combines all the air quality criteria and climate change aspects using the synergies to develop local emission inventories was not developed and is still lacking

2.11.3 Information on policies and measures

Fairmode is a portal which offers information concerning the AQD. Submitted compliance data are based on model results, references and experiences of other users through case studies. With the Delta tool a benchmarking service was integrated to produce automatically reports on model performances. The content of the reports should include both quantitative and qualitative information, based on the selected core indexes and summary diagrams applied on the reduced set.

A draft document of recommendations for the review of the AQ directive as deduced from the consultation and discussions held so far with the community on the EU AQ Policy[16] is presented. It includes a clear statement on the necessity of a further and continuing discussion with the FAIRMODE community recommends the enhanced work for a compilation and quality assurance of urban emission data.

[16] http://fairmode.ew.eea.europa.eu/guidance-use-models-wg1/directive-revision/basic-recommendations-from-fairmode-to-the-review-of-the-eu-air-policy-6.docx

2.11.4 Project networking, results

Fairmode is an EU-wide Air Quality Modelling Network and support the implementation of the revised EU Air Quality Directive. Several documents could be developed by the different working groups. The key results of the initiative can be summarized as follows:

- Inverse assessment models are necessary for quality assurance of plans and measures to control AQ exceedances;
- Model Quality Objectives (QO, e.g. uncertainty description of models) have to be defined more precisely. For modelling it should be stated precisely for modelling what the uncertainty will be compared to;
- It remains necessary to combine models and measurements for activities : assessment of air quality levels and establishing the extent of exceedances;
- Quality assurance of emission inventories; and
- Definition of criteria for the future development and organization of the monitoring networks necessary.

2.12 The clustering of projects

In this chapter the methodology for the possible clustering of the different projects or initiatives on the basis of the matrix table (see Annex) is described by analyzing the identified studies against various axes.

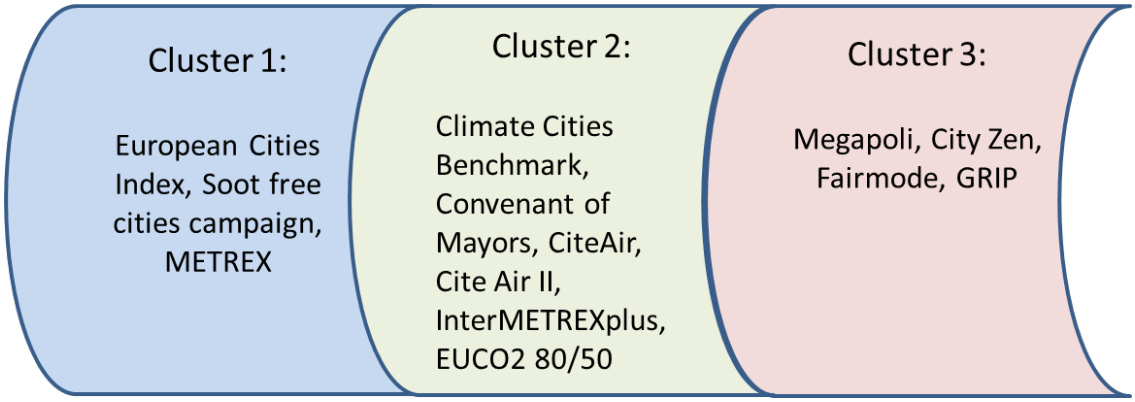
Cluster 1 takes into account local campaigns/initiatives/networks, which draw upon measures and local action plans but do not compile emissions themselves.

Cluster 2 takes into account a hybrid approach. Local emission inventories/air quality indicators were developed by the project and applied for the compilation of emission inventories by local authorities. This enables actions plans to be developed by third parties.

Cluster 3 takes into account a scientific approach. That means that a project or a cooperation of numerous scientists examine climate effects by compiling emission inventories, observing satellite data and conducting measurements by stations (integrated assessment modelling), GHG and AP. As a final objective the project supports politicians or local authorities in the implementation of improved regulations or local action plans.

The following Figure 2-9 presents the structuring of the studies analyzed.

Figure 2-8 Cluster aggregation of the different Megacity projects

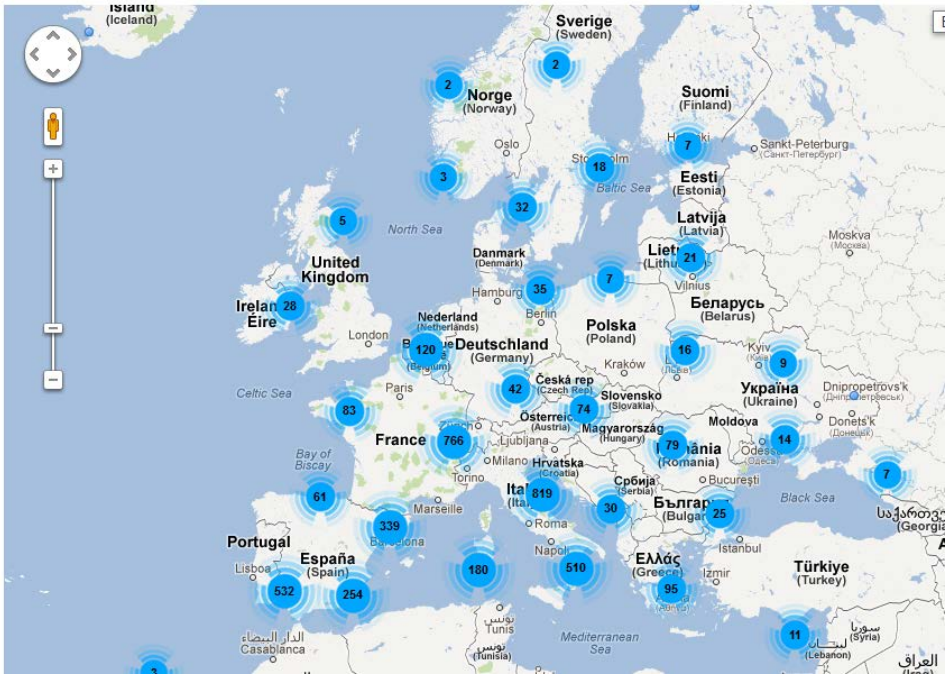


The results of the analysis can be summarized as follows:

- **Cities involved**

  Most of the Mega cities campaigns take into account the major capitals in the western part of Europe. Cities in the Eastern part (see Figure 2-10) are not as well regulated regarding air quality and climate change and not very often involved in the presented campaigns. The integration of this part should be encouraged. Further examinations of the cities of Berlin, Madrid, Malmö, Milan, Ploiesti, Prague, Vienna and Dublin are envisaged in Part 2 of this study.

Figure 2-9 Map of Covenant of Mayors, Signatories



Source: Covenant of Mayors, http://www.eumayors.eu/about/covenant-of-mayors_en.html

- **Transparency and comparability**

  Having reviewed all the offered information about the campaign/projects it became evident that there are a lot of documents available but the core information about the local authorities, data, applied methodology can only be accessed with intensive digging. This study would welcome any development towards greater transparency about the description of the methodology, the campaign/project structure itself and the comparability of results regarding the compiled emission inventories. Although all the methodologies are generally modelled in line with the IPCC or UNECE/ EMEP guidelines, they differ in many aspects. The information of the used emission inventories about the compilation date (not inventory year) is not given. Due to the different recalculation processes inventories from one to another inventory year can differ dramatically depending on the sector. Therefore, an update or follow-up project after, for example, three years has to be taken into account.

  Furthermore, the degree of urgency with which climate change needs to be tackled and the long lifespan of urban infrastructure means that cities need to take well-informed and effective decisions quickly. Greater compatibility of tools would render it easier to compare results and thus facilitate this process.

- **Guidelines/ guidebooks**

  The study assessed that for emission inventories guidance documents were developed (see GRIP, Covenant of Mayors, IMACE guidebook of CITEAIR) or the compilation methodology for the development of an emission inventory was in line with the respective international guidelines (IPCC or UNECE/EMEP). Furthermore, for the implementation of AP/CC policies and measures best practice examples per technology (e.g. Sootfree city campaign) or region (see Covenant of Mayor, Klimaschutz in Kommunen, climate cities benchmark) were developed.

- **Pollutants**

  The selection of evaluated pollutant or GHG combinations varies extremely and depends on the objective of the analysis. Some projects or campaigns take into account only CO_2, others cover GHG (considering the six gases of the Kyoto Protocol). Additional, particulate matter like black carbon (soot) or particulate matter taking into account the different sizes (aerosols) were considered for air quality reasons. Due to the different air quality protocols (e.g. Multi pollutant protocol) the amount of or impact of ozone precursors (CH_4, NOx, CO, NMVOC) and eutrophication substances (SO_2, NO_x, NH_3, VOC) were studied. However, the biggest share of CO_2 equivalent emissions is covered by local inventories. Co-benefits of AP and CC mitigation strategies are part of the main focus. The integration of the amount of noise and other pollutants should be encouraged, even more so if there is evidence of the relative importance of a specific gas for the overall emissions.

- **Emission inventories**

  Most of the campaigns used bottom-up emission inventories for estimating CO_2 emissions. The emission inventories normally include all the relevant energy sectors (e.g. energy consumption of residential, industry or public transport). Additional sectors like agriculture, land use change and forestry or diffuse emissions are not considered in general. Results of the emission inventories on a local scale (see InterMETREX plus) are published in the respective publication, flyer or deliverable report. However, the activity data or emission factors used are not available (in particular for the baseline emission inventory which is compiled from the different signatories of CoM).

  Furthermore, satellite observations results were combined with national emission inventories (top down approach) or stationary measurements to study the impact of AP and GHG on climate and regional or local conditions. Therefore, a more comprehensive study considering one city inventory and comparing the results or applying new tools would explore the main aspects and show the main uncertainties.

  For many inventories the uncertainty of results is not published. It has to be taken into account what kind of accuracy (TIER level) was applied when the inventory was compiled.

- **Policy and measures**

  Most of the studies/campaigns do not link co-benefits of APs with GHGs (CC measure). Only research projects do so (Cityzen, Megapoli and CiteAir) but AQ is in particular a local and regional problem and local policy have to take this into account as well (see CiteAir). By collecting the SEAP baseline emission inventory it could be extended with AP emission factors. A combination of AP measurements and these SEAP baseline emission inventories would improve knowledge about the status quo for a region. Furthermore, local measures can be derived for the AP mitigation strategies and the action plans can be extended as well (e.g. with the Climate Cities Benchmark tool ECOregion).

- **Sectors (transport in this case)**

  Sectors are defined as the aggregation of specific emission sources. The emissions of the transport sector could differ in the way aviation emissions are considered. Sector-specific emissions can only be compared if the sectors are defined in exactly the same way, i.e. they cover the same emission sources. Therefore, it is necessary that IPCC guidelines, for example, are applied as a common base for local inventories.

  All studies which compile inventories consider road transport. A comparison of data is not possible because local emissions inventories are not accessible for the public or the emissions per sector and region were not published. The CiteAir project publishes air quality indices (but not real time measurement results) on its webpage. Therefore, only information about air quality is given but the information is not comparable. Campaigns like ‘Soot free cities’ refer to sustainable local transport measures which include:

- traffic and mobility management,
- promotion of public transport, and
- promotion of cycling and walking.

National policy can influence:

- emissions reductions which can be realized through efficiency improvements and fuel switching to electric-mobility, hydrogen and bioenergy;

- total fuel consumption from fleet and total miles driven from fleet, and average fleet fuel efficiency and total airline miles travelled due taxation and promotion.

3 Conclusion

This project has shown that many there are already advanced campaigns/projects with tools in different European countries, highlighted the main methodological challenges of local GHG/AP accounting and presented an analytical framework for the assessment of inventory tools and methodologies. This report provides a brief conclusion about the results of different Megacity projects:

- Any of the presented projects considered the amount of noise produced as a co-benefit of CC/AP abatement strategies. Noise correlates in particular with better technical development of engines in the transport sector (aviation, on and off road). Furthermore, by combining the AP and CC emission inventories on a local scale the challenge in addressing air pollution and climate change over the coming decades will be to maximize synergistic policies at international, national, regional and local level and can be fully exploited in a cost-effective manner. Most of the inventories take account of CO_2 only; others cover CO_2, methane and nitrous oxide while other inventories cover only AP. A protocol could require emissions to be reported for at least the three most important GHG, i.e. CO_2, methane and nitrous oxide. The inclusion of further gases should be encouraged, even more so if there is evidence of the relative importance of a specific gas for the overall emissions.

- The cities of Eastern Europe should be more involved and considered in further campaigns or studies. In particular, regarding the prognostic population increase the cities in the Eastern part will grow until 2050. Certainly, one of the key findings (which could be expected) is that there is significant positive correlation between wealth (GDP per capita vs. European city index score) and environmental performance. Nordic cities dominate the top ten list. Copenhagen leads the index overall and in comparison with the 'Soot free cities campaign' the ranking of the cities are similar for the Nordic capitals. Therefore, Eastern Europe should be more considered.

- In the previous chapters most of the projects suggested that emission inventories for the comparison of the results from the city reporting should be improved and more comparable air quality measurements or local statistics for calculating emission inventories on local level should be promoted. But it should be stressed that the main question is not whether there is greater comparability possible. Regarding the improvement of urban sustainable infrastructure cities need to take well-informed and effective decisions quickly. Greater compatibility of tools to create action plans would render it easier to compare results and thus facilitate this process.

- Beyond this, one of the key sectors for increasing the abatement of air pollution, noise and climate change is the transport sector. One pillar of this abatement will be to develop new, individual transport concepts as offered by automobile companies today (sharing vans, cars, scooters or bikes). Further technical improvement and in particular the implementation of regulatory instruments like subsidies to support regional and inner city transport service will be the other – and particularly challenging – pillar.

4 Abbreviations

AP	Air Pollutants
AQ	Air Quality
BAT	Best available technique
BC	Black carbon
CC	Climate Change
CH_4	Methane
CiteAir	Common Information to European Air
CLRTAP	Convention on Long-Range Transboundary Air Pollution
CO	Carbon monoxide
CO_2	Carbon dioxide
CoM	Covenant of Mayors
CoMO	Covenant of Mayors Office
CTM	Global Chemical Transport Model
EEA	European Environment Agency
EIB	European Investment Bank
EMEP	European Monitoring and Evaluation Programme
ETC/ACM	European Topic Centre for Air Pollution and Climate Change Mitigation /
ETS	Emissions Trading Scheme
EU	European Union
GAW	Global Atmosphere Watch
GHG	Greenhouse Gases
GCM	Global Climate Model
GRIP	Greenhouse Gas Regional Inventory Project
GURME	GAW Urban Research Meteorology and Environment Project
ICT	Information and communication technologies
IPCC	Intergovernmental Panel on Climate Change
JRC	Joint Research Center
LCA	Life Cycle Assessment
MS	Member States

Megapoli	Megacities: Emissions, urban, regional and Global Atmospheric POLlution and climate effects, and Integrated tools for assessment and mitigation
NEC	National emission ceiling
NiCE	Networking intelligent Cities for Energy Efficiency
NH_3	Ammonia
NMVOC	Non Methane Volatile Organic Compounds
NOx	Nitrogen oxides
N_2O	Nitrous oxide
PM 10	Particulate Matter < 10 µm
PM2.5	Particulate Matter <2.5 µm
SOx	Sulphur dioxide
SEAP	Sustainable actions plan
SNAP	Selected Nomenclature for Sources of Air Pollution
TAR	Third Assessment Report
TCCCA	Transparency, Comparability, Consistency, Completeness, Accuracy
UBC	Union of the Baltic Citites
UNECE	United Nation Economic Commission for Europe
UNFCCC	United Nation Framework Convention on Climate Change
VOC	Volatile organic compounds
WMO	World Meteorological Organisation

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Annex 1 Overview of different city campaigns or projects

		Cluster	Cluster 1	Cluster 1	Cluster 1
Actions	**Details**	**Project**	**European City Index**	**Soot free cities campaign**	**Metrex**
Overview		**Project Website**	http://www.siemens.com/entry/cc/en/greencityindex.htm	http://sootfreecities.eu/	http://www.eurometrex.org/
		Name and contact details of project coordinator	Karen Stelzner, Siemens AG	Bund für Umwelt und Naturschutz Deutschland e.V. (BUND) – Friends of the Earth Germany Am Köllnischen Park 1 D – 10179 Berlin	Hannu PENTILLÄ (President) METREX 125 West Regents Street (Lower Ground Floor) GLASGOW G2 2SD Tel: +44 (0)129 231 7074 Fax: +44 (0)129 231 7074 enquiries@eurometrex.org
		What are the project's objectives?	It takes into account 30 individual indicators per city, touching on a wide range of environmental areas, from environmental governance and water consumption to waste management and greenhouse gas emissions. Finally it offered a tool to enhance the understanding and decision-making abilities of all those interested in environmental performance, from individual citizens through to leading urban policymakers.	To demonstrate that local abatement plans to improve air quality exist and to find out how cities use these solutions.	The Network of European Metropolitan Regions and Areas, provides a platform for the exchange of knowledge, expertise and experience on metropolitan affairs, and joint action on issues of common interest
		Who is going to perform/participate on the project?	30 cities, among them are European Union capitals and others are researched by Siemens and the economists union.	Deutsche Umwelthilfe e.V., Naturschutzbund Deutschland e.V., Verkehrsclub Deutschland e.V., ClimateWorks Foundation and the ranked cities	Network has members from some 50 metropolitan regions and areas and partners in many others
		What are the future prospects/follow projects?	cities on different continents are investigated as well; resulting in comparability of investigations	The measurement campaign is being continued	The network is being continued.
		In what manner is the project going to be realized?	a study is beeing elaborated	The methodology for analysing and evaluating the cities' responses was based on the same method used by BUND for their two German city rankings.	Metrex is split in five sub projects: EUCO2 80/50 Project InterMETREXplus Project InterMETREX Project PolyMETREX Project SocioMETREX Project
		Description of study's (Projects) final deliveralbels	Studies and Benchmarks	City ranking on website	Reports for the main activities and background information of the different projects are online available:
		Updates planned? Update frequency?	No update planed	The campaign is being continued.	Annual conferences about future activities
		Organisation / entitiy who is responsible for the emission inventory.	The Economists Intelligence Union elaborate the study, sponsored by Siemens	Bund für Umwelt und Naturschutz Deutschland e.V. (BUND) – Friends of the Earth Germany Am Köllnischen Park 1 D – 10179 Berlin	GRIP was developed under the METREX project
		Project duration	From 2009 until today	started in March 2009	Since 1996 ongoing network
		Which cities were involved?	All 30 capital cities of EU countries and some neighboring countries	17 European cities: Amsterdam, Berlin, Brussels, Copenhagen, Düsseldorf, Glasgow, Graz, London, Lyon, Madrid, Milan, Paris, Rome, Stockholm, Stuttgart, Vienna, Zürich	Not considered

		Cluster	Cluster 1	Cluster 1	Cluster 1
Actions	**Details**	**Project**	**European City Index**	**Soot free cities campaign**	**Metrex**
Emissions inventories at local level	**Substances**	**Pollutants included? (list) GHGs: APs:**	CO2 emissions and air pollutants (NOx, SO2, O3, PM10, SOx)	PM10 (soot)	Metrex itself does not refer about emissions but their subprojects like EUCO2
		Noise information included?	No information concerning noise issues	No information concerning noise issues	No information concerning noise issues
		Are there activity data (e.g. local statistics, information about energy consumption) available/ used?	Primary sources included national statistical offices, local city authorities, and city and national environmental bureaux, activity data are not public available.	The point Transparency & Communication Policy is linked with information about air quality of the local entity. Therefore, measurement results are linked. But there is no publication of the initiative available which gives an overview about the local data itself. Furthermore, technical fact sheets give background information about emissions and trends.	No
		Is database/emissions data publicly available? If yes - address for download. If no - is it available on request?	Yes, in document and website http://www.siemens.com/entry/cc/de/greencityindex.htm	http://sootfreecities.eu/city	GRIP is supported by METREX
		Timeseries available?	Only for 2007	No	No
		Data quality (TCCCA with focus on comparibility and methodology)	Data was collected with especialy elaborated questionairs following a TCCCA compilant methodology	20 municipalities received a detailed questionnaire; 14 cities provided answers and 17 cities have been ranked.	EUCO2 and GRIP are subprojects of METREX
	Sectors	**Stationary Sources (e.g. Power plants)**	Yes	Yes	METREX itself does not measure any pollution or GHG nor is there a inventory
		Industry and Residentials	Yes	Yes	No information available
		Mobile Sources (Transport)	Yes	Yes	No information available
		Other Diffuse Sources	Water and wastewater treatment	Non road vehicles and heavy machinery	No information available
		Agriculture	Environmental Government	No	No information available
	Guidance	**Description of methodology followed**	Bottom up emission city inventory used	1. Reduction success: urban traffic stations minus regional background stations 2. LEZ, bans of heavy emitters (i.e. heavy goods vehicles) 3. Public procurement / cleaner fleets 4. Non-Road Mobile Machinery (NRMM) 5. Economic instruments (Congestion Charge, Parking Management, subsidies, etc.) 6. Traffic and mobility management (modal split as background information) 7. Promotion of public transport 8. Promotion of cycling and walking 9. Transparency and communication	see Grip
		Name of any guidance documents used/suggested	Methodology described in the report for the different categories: CO2, Enery, Buildings, Transport, Water, Waste and Land use, Air Quality, Environmental Governance	SOOT FREE CITIES Best practice examples from German and European cities for reducing soot from traffic (bc_measures_2012.pdf)	see GRIP
		Web address for guidance document	http://www.siemens.com/entry/cc/en/greencityindex.htm	http://www.russfrei-fuers-klima.de/international/publications/	see EUCO2 80/50
		Total Project cost	No information available	No information about total budget available.	In general, the network is self-funded and meetings are paid be delegates fees.
		Cost evaluation for cities	No information available	There is information about project budgets published: Technical measures – Particulate filters, Regulatory measures - Environmental zone, Pricing measures - Congestion charge, Organisational measures - Public transport priority, Infrastructural measures: reallocation of road space, Promoting EcoMobility	No information available

		Cluster	Cluster 1	Cluster 1	Cluster 1
Actions	**Details**	**Project**	**European City Index**	**Soot free cities campaign**	**Metrex**
Information on policies and measures		**Is information available on implementated and/or planned policies and measures in the cities?**	The study represents the current status of the city in therms of climate change	Yes, there were investigations in each city: Technical measures – Particulate filters, Regulatory measures - Environmental zone, Pricing measures - Congestion charge, Organisational measures - Public transport priority, Infrastructural measures: reallocation of road space, Promoting EcoMobility	No
		General description of information	Yes in report described.	Interactive map on website	In general, information on policies and measures is not in the focus, but furter information can be found under the different projects or meeting descriptions.
		Does the study assess the effectiveness of these measures? Quantitative? Qualitative?	Yes. See Tab. List of categories, indicators and their weight in the report	Yes.- evaluating the measures in cities and show the result in ranking on website	No
		Does the study look at co-benefits of AQ and GHG policies?	No	First, the aim is to reduce Black carbon which has also a global warming potential and harms health as an air pollutant. But co-benefits are not focused in this initiative.	No
		Does the study look at co-benefits of AQ/GHG policies with noise?	No	No	No
		Does the study link air emission inventories with an assessment of AQ in the cities covered?	No	No	No
		If yes, brief description of the methods used, models etc	No	No	No
		Are specific 'good practices' identified? If yes, what are these?	No	SOOT FREE CITIES Best practice examples from German and European cities for reducing soot from traffic (bc_measures_2012.pdf)	No
Conclusions/other		**Was there a network or 'sharing' forum set up for the cities participating in the study? If yes, details**	No	There is a ranking on the website, showing the measured results	METREX offers a network which was made to dissaminate information.
		Was there a list of findings/conclusions from the study? If yes, summarise all main conclusions	Nordic cities dominate the index top tier. There is a strong correlation between wealth and a high overall ranking on the index. Wealthier cities can invest more money in energy-efficient infrastructure and afford specialist environmental managers. Among east European cities (which also represent the low-income cities of the index), Vilnius performs best of all, ranked in 13th place. It is followed most closely by Riga, in 15th place. Smaller cities have a better performance for environmental protection and abatement of air pollution. People have to take only small ways in purchase. Cities with an active civil society perform well in the index. Although it was beyond the scope of this study to measure specific citizen engagement in environmental issues, a strong correlation exists between high-performing cities in this index and other independent studies that explore the strength of civil society in European countries.	SOOT FREE CITIES Best practice examples of German and European cities for reducing soot from traffic (see document bc_measures_2012.pdf); a combination of approaches for each individual city: *technical air quality measures (on cars, lorries, construction machinery, buses, trains, etc.) *and measures to reduce individual motorised transport, for example through improvements of cycling and public transport. *Environmental zones, which lead to a modernisation of vehicle fleets, are the most effective single measure, but they alone will not suffice. Therefore, every city has to develop its own action plan and consistently implement it.	METREX does accomondate other projects and acts as a rooftop organisation, Metrex Manua, METREX website: www.eurometrex.org

		Cluster	Cluster 2	Cluster 2	Cluster 2
Actions	**Details**	**Project**	**Climate Cities Benchmark (Climate Alliance)**	**Convenant of Mayors**	**CiteAir**
Overview		**Project Website**	http://www.klimabuendnis.org/home.html?&L=0	http://www.eumayors.eu/about/covenant-of-mayors_en.html	http://citeair.rec.org/home.html
		Name and contact details of project coordinator	The European Secretariat Executives Ulrike Janssen and Thomas Brose Climate Alliance Galvanistr. 28, 60486 Frankfurt am Main Germany Tel. +49-69-717139-0 Fax +49-69-717139-93 Email europe(at)climatealliance.org	97 Covenant Coordinators (2012-03-12)	INTERREG IIIC; Nick Hodges Leicester City Council 91 Granby Street UK-Leicester LE16FB Tel.: +44.116.299.5690 Fax: +44.116.255.7997 Email: hodgn001@leicester.gov.uk
		What are the project's objectives?	To analyse and balance CO2 emissions, comparing climate city activities for better understanding of onsite mitigation potentials	From 2008 onwards the Covenant of Mayors supports the efforts deployed by local authorities in the implementation of sustainable energy policies. The goal is to increase energy efficiency and use of renewable energy sources on their territories and to abate CO2 emissions. By their commitment, Covenant signatories aim to meet and exceed the European Union 20% CO2 reduction objective by 2020.	to jointly develop better and more efficient solutions for assessing the impact of traffic on air quality in large urban areas, to inform professional users and the public on the environmental situation based on common guidelines , to give guidance on efficient measures to abate adverse environmental situations through close co-operation, experience exchange and joint developments with European Cities and Regions
		Who is going to perform/participate on the project?	Presently more than 1600 cities, municipalities and districts as well as provinces, NGOs and further organisations are members of Climate Alliance. Mailny EU Countries http://www.klimabuendnis.org/fileadmin/inhalte/dokumente/2012/Mitgliederliste_international_February_2012.pdf	Local and regional authorities of the European Union 27 (are participating in Convenant of Mayors for Europe)	stakeholders are EEA, Core Cities (Leichester, Paris, Rotterdam, Rome, Prague, Munich, Emilia Romanga, The Hague, Bratislava, Brussels) European Commission (DG Environment)
		What are the future prospects/follow projects?	there are no follow projects announced	to translate political commitment into concrete measures and projects	project has came to a halt in 2007; current Project - Cite Air II
		In what manner is the project going to be realized?	The Climate Cities Benchmark consists of four elements: 1. City fact sheets, 2. Activity profiles, 3. CO2 emission display, 4. Set of indicators	Signatories represent cities, with different size from small villages to major metropolitan areas such as London or Paris, that have signed the Covenant of Mayors on a voluntary manner. : Reporting of Baseline Emission Inventory and Sustainable Energy Action Plan from every entity	The main developments underpinned by products of CITEAIR are: Air quality Index CAQI and YAQACI – The first Air Quality indices on the European level The Common Operational webpage (COW) – An interactive webservice to display and compare air quality across cities Communicating Air Quality – A guide and practical examples to communicate with the public Proposal for a City Annual Air Quality Reports – A common reporting format and a semi-automatic report generator Air quality management – To assist cities to identify tools and measure to improve air quality Transferring a traffic-environmental modelling chain – The implementation of a Decision Support System
		Description of study's (Projects) final deliveralbels	Description of the project , inventory and scenario tool are published on the webpage	Signatories elaborate a sustainable energy action plan (SEPA)	The project supports cities and regions in developing efficient means to collect, present and compare air quality data
		Updates planned? Update frequency?	No information is given.	Signatories will have to submit a report evaluating results the state of implementation of actions every 2 years and emissions inventories every 4 years.	project was continued by Cite Air II
		Organisation / entitiy who is responsible for the emission inventory.	www.ecospeed.ch	First, the local entitiy of the municipality is responsible to report a baseline emission inventory. Conveant of Mayors is using GRIP and GRIP Methodology	Co-funded by the European Union's INTERREG IIIC Programme
		Project duration	Focused on GHG mitigation until 2020	According to the project object the duration will last until 2020.	The project started in March 2004 and runs until the end of 2007.
		Which cities were involved?	http://www.klimabuendnis.org/map_members.html?&L=0	3688 signatories (Municipallities) including 157.294.461 inhabitants up to March 2012; Berlin, Madrid, Malmö, Milan, Dublin, Bucharest	The core cities Leicester (UK), Paris (FR), Prague (CZ), Rotterdam (NL), Rome (I) and most of the fol-lower cities Munich (DE), Coventry (UK), den Hague (NL), Bratislava (SK) and Brussels (BE)

		Cluster	Cluster 2	Cluster 2	Cluster 2
Actions	**Details**	**Project**	**Climate Cities Benchmark (Climate Alliance)**	**Convenant of Mayors**	**CiteAir**
Emissions inventories at local level	**Substances**	**Pollutants included? (list) GHGs: APs:**	GHG (CO2)	CO2	PM10/2.5, NOx, O3, SO2, VOC, HC, CO
		Noise information included?	No information concerning noise issues	No information concerning noise issues	No information concerning noise issues
		Are there activity data (e.g. local statistics, information about energy consumption) available/ used?	26 action fields in the following categories: climate policy, energy, transport and waste	Activity data (e.g. local energy consummption in MWh) and emissions are reported in the SEAP template but not officially published. It might be, that the local entities could provide the information.	Annual inquieries with special Questionnaire to report air quality measurements, implementing a common air quality index (CAQI) and Year Average Common Air Quality Index (YACAQI) for comparison reasons
		Is database/emissions data publicly available? If yes - address for download. If no - is it available on request?	no, Login necessary http://www.benchmark-kommunaler-klimaschutz.net/	The database and emissions are not published itself.	www.airqualitynow.eu
		Timeseries available?	1990 - 2007	In some SEAP reports time series of CO2 are available.	No
		Data quality (TCCCA with focus on comparibility and methodology)	data quality regulations are 100% compliant with Convenant of Mayors	The data quality depends on the municipialities and to get a high emission inventory to build a complete CO2 emission inventory, based on actual energy consumption data; work is being done by local entities; so that the quailty depends on their work	Air quality has been assessed by CAQI and YACAQI indices
	Sectors	**Stationary Sources (e.g. Power plants)**	Yes	Yes	No
		Industry and Residentials	Yes	Yes	No
		Mobile Sources (Transport)	Yes	Yes	Yes
		Other Diffuse Sources	Yes	No	No
		Agriculture	Yes	No	No
	Guidance	**Description of methodology followed**	Hybrid aproach - with a combination of bottom up and top down	Top down methodology which was elaborated to guide local entities on their way to a emission inventory	Bottom up methodology - Communicating Air Quaity to the public but using voluntary sources
		Name of any guidance documents used/suggested	ECORegion is a comercial product of a swiss company. Inside Login-Area one can find a manual and a methodology	SEAP guidelines	Guidebook on integrated emission inventories (also: IMACE database and IMACE guidebook) # Guidebook on Air quality forecast # Guidebook on mobility and exposure indicators
		Web address for guidance document	www.ecospeed.ch	http://www.eumayors.eu/IMG/pdf/seap_guidelines_en-2.pdf	http://citeair.rec.org/downloads/Products/CommunicatingAirQuality.pdf
		Total Project cost	No information available	Estimation of 36 % of the EU budget for the period 2007 – 2013	No information about total budget available.
		Cost evaluation for cities	No information available	Cost for the respective actions plans are reported in the SEAP template but not available for the public.	No information available

		Cluster	Cluster 2	Cluster 2	Cluster 2
Actions	**Details**	**Project**	**Climate Cities Benchmark (Climate Alliance)**	**Convenant of Mayors**	**CiteAir**
Information on policies and measures		**Is information available on implementated and/or planned policies and measures in the cities?**	No	Yes. The SEPA every municipallity hands in describes local measures	Yes, there are numerous Guidance documents describing measures
		General description of information	Local authorities can compile a CO2 inventory which is comparable to other	Sustainable energy action plan (SEPA) is a document, elaboratet by local administrations on behalf of the CoM guideline	Interactive map on website http://www.airqualitynow.eu/
		Does the study assess the effectiveness of these measures? Quantitative? Qualitative?	Yes	No	Yes, the effectivness is one of the criterias
		Does the study look at co-benefits of AQ and GHG policies?	No	No	Yes, the project aim is to do research especially on air quality including GHG
		Does the study look at co-benefits of AQ/GHG policies with noise?	No	No	No
		Does the study link air emission inventories with an assessment of AQ in the cities covered?	No	No	Yes
		If yes, brief description of the methods used, models etc	Description of analyzing steps to get an action plan: a city fact sheet, an activity profile, CO2 emission time series from 1991 – 2005 (later 2009) and a set of 17 indicators	No	Preparation of a local emission inventory considering AP and CO2
		Are specific 'good practices' identified? If yes, what are these?	Praxisleitfaden Klimaschutz in Kommunen	The UBC Good Practices Database offers good practices from the Baltic Sea region. It was developed to answer to the need of local authorities to find practical examples complemented with suitable tools. The practices cover sustainable development in cities including all topics from transport to health and from social aspects to economic instruments. http://www.ubcwheel.eu/	No
Conclusions/other		**Was there a network or 'sharing' forum set up for the cities participating in the study? If yes, details**	The climate cities benchmark is presented on the webpage of the Climate Alliance and programmes, events or presentation are published there.	Yes, there is the 'EUROCITIES' network which give support for the communication and organisation of meetings betweenthe local entities. Furthermore, The Covenant of Mayors Office (CoMO) is managed by a consortium of local and regional authorities networks, led by Energy Cities, composed of Climate Alliance, CEMR, Eurocities and Fedarene. With an annual Award for the best SEAP the municialities are honored. A monthly newslater provide information for the local entities (e.g. financing of projects) and with the Benchmark of Excellence of the local initiatives an outstanding project is proposed.	The internet presentation of the project allowed communication, announcement of meetings and publication of reports and scientific literature.
		Was there a list of findings/conclusions from the study? If yes, summarise all main conclusions	Development of an activity profile per community which shows the status and degree of implementation of mitigation measures in the four priority areas of climate policy, energy, transport and waste management. Development of specific indicators to assess the effects of the urban climate protection efforts.	No, the conclusions and findings come from the different signatories. It is more interpretating as an aim for mitigation of GHGs	•Air quality Index CAQI and YAQACI – The first Air Quality indices on the European level •The Common Operational webpage (COW) – An interactive webservice to display and compare air quality across cities •Communicating Air Quality – A guide and practical examples to communicate with the public •Proposal for a City Annual Air Quality Reports – A common reporting format and a semi-automatic report generator •Air quality management – To assist cities to identify tools and measure to improve air quality •Transfering a traffic-environmental modelling chain

		Cluster	Cluster 2	Cluster 2	Cluster 2
Actions	**Details**	**Project**	**Cite Air II**	**InterMETREXplus**	**EUCO2 80/50 - Metrex**
Overview		**Project Website**	http://www.citeair.eu/	http://www.eurometrex.org/ENT1/EN/Activities/activities.asp?SubCat1=InterMETREXplus	http://euco2.eu/index.html
		Name and contact details of project coordinator	INTERREG IVC	Led by GCVSPJC, it involves 32 metropolitan partners and has run from 2003-2006 with a	Rainer Scheppelmann International Climate Cooperation Coordinator EUCO2 80/50 Ministry of Urban Development and Environment Coordination Centre for Climate Issues Stadthausbrücke 8 D-20355 Hamburg Tel.: 0049 40 42840 2536 Mobil: 0049 171 223 14 03 Mail: rainer.scheppelmann@hamburg.de
		What are the project's objectives?	to provide up-to-date information on air quality, greenhouse gases and emissions in European cities to local and regional authorities, the public and the media and enhance comparability of cities through the interactive website www.airqualitynow.eu, to identify, test and transfer good practice to describe the traffic situation and its impact regarding CO2 emissions in urban agglomerations by a mobility indicator; a nd to identify, test and transfer good practice to integrate greenhouse gases into existing air pollutant emission inventories for regulated pollutants and to select measures with a combined effect on reduction of urban pollutants and greenhouse gases. • Identify, test and transfer good practice for dedicated urban air quality forecasting addressing different levels of complexity that meet the needs of cities and regions depending on their local skills, resources and level of expertise;	1. to develop the GRIP GHG inventory methodology in a user friendly tool that it could be applied to all the pilot regions; and 2. to test the GRIP scenario tool at the metropolitan regional scale: Glasgow and the Clyde Valley.	18 European metropolitan regions aim to devise strategies for achieving an 80% reduction of greenhouse gases emissions by the year 2050
		Who is going to perform/participate on the project?	CITEAIR II partners •Airparif (Lead partner) •ARMAAG •CHMI •DCMR •Egmasa •INERIS •Maribor •Polis •Prague •REC •Rome mobility agency	GCVSPJC Lead Partner > METREX > Stockholm > Andalucia > South Coast Metropole (SCM) Southampton > Tyndall Centre > London Climate Change Agency > Paris IAURIF > Helsinki, Rotterdam, Birmingham	18 european metropolitan regions Lead partner and Coordinator is the Metropolitan Region of Hamburg
		What are the future prospects/follow projects?	Information on Air Quality including pollutants and GHG is being dissaminated on website www.airqualitynow.eu	EUCO2 80/50	After the production of regional greenhouse gas inventories, political and economic stakeholders come together in scenario/strategy workshops in order to find a consensual long term CO2 reduction strategy
		In what manner is the project going to be realized?	Identifying best practises, refining them and dissaminate Gudebooks concluding the measures	as a pilot project in a smaller dimension	1. Compilation of regional energy data is being compiled 2. Simulation, of greenhouse gas reduction scenarios with the GRIP model 3. Strategy workshops with participation of regional stakeholders where specific strategies should be proposed to the political, economical and social decision makers at the end of the GRIP process.
		Description of study's (Projects) final deliveralbels	# Forecasting common air quality indices # Integrating greenhouse gases emissions # Benchmarking mobility emissions # City comparison	Comparable emission inventory for each country/region taking demographic and economic data into account	EUCO2 80/50, Climate Change / Urban Change, Outline Prospectus
		Updates planned? Update frequency?	Ongoing measures and result publication on http://www.airqualitynow.eu/	No	Implementation of effective metropolitan mitigation practice dissemination
		Organisation / entitiy who is responsible for the emission inventory.	CITEAIR II partners •Airparif (Lead partner), •ARMAAG, •CHMI, •DCMR, •Egmasa, •INERIS, •Maribor, •Polis, •Prague, •REC, •Rome mobility agency	GRIP is a webbbased tool developed by Tyndall University	see GRIP
		Project duration	2008 to 2011	former project InterMETREX (2003-2006), InterMETREXplus duration nine months (End June 2007)	2009 - 2012, (2008 - 2010)
		Which cities were involved?	Over 90 european cities (http://www.airqualitynow.eu/comparing_cities_page.php), mainly Maribor, Paris, Prague, Rome, Rotterdam, Gdansk and Seville	> London Climate Change Agency > Paris IAURIF > Helsinki, Rotterdam, Birmingham	18 european metropol regions Brussels - Frankfurt - Glasgow - Hamburg Helsinki - Madrid - Naples - Oslo - Paris Porto - Rotterdam - Stockholm - Stuttgart - Turino

		Cluster	Cluster 2	Cluster 2	Cluster 2
Actions	**Details**	**Project**	**Cite Air II**	**InterMETREXplus**	**EUCO2 80/50 - Metrex**
Emissions inventories at local level	**Substances**	**Pollutants included? (list) GHGs: APs:**	PM10/2.5, NOx, O3, SO2, VOC, HC, CO	GHG emissions (CO2, CH_4, HFC, PFC, SF6, N2O)	CO2, CH4, HFC, PFC, SF6, N2O, but focused on CO2 emissions equivalents
		Noise information included?	No information concerning noise issues	No information concerning noise issues	No information concerning noise issues
		Are there activity data (e.g. local statistics, information about energy consumption) available/ used?	there are third party entities, who deliver AQ infos, also on their own platforms	Yes. The tool was made to collect data from Energy, Industrial Processes, Waste, Agriculture from local entities	The GRIP inventory was used.
		Is database/emissions data publicly available? If yes - address for download. If no - is it available on request?	www.airqualitynow.eu	Yes http://www.carboncaptured.org.uk/results/	GRIP is applied
		Timeseries available?	No	No	No. Baseyear 2005, scenario year 2050
		Data quality (TCCCA with focus on comparibility and methodology)	That was not in the focus of the follow.up project.	GRIP methodology - pilot project. Data quality depends on the regional level. 1 national total (low uncertainty), 2. regional total (medium uncertainty), 3. local scale (very high uncertainty, data not always available).	According IPPC Guidelines 1996 and GRIP inventory
	Sectors	**Stationary Sources (e.g. Power plants)**	Yes	Energy Industry,	Energy Industry,
		Industry and Residentials	Yes	Industrial Processes	Industrial Processes
		Mobile Sources (Transport)	Yes	Transport	Transport
		Other Diffuse Sources	na	Waste, Fugitive emissions,	Waste, Fugitive emissions,
		Agriculture	No	taken into account	taken into account
	Guidance	**Description of methodology followed**	There are several methodologies for developing an emission inventory on local scale and a guidebook about air quality forecasting pulished: (http://www.citeair.eu/fileadmin/Deliverables_and_documents/Guidebook_Integrated_Emission_Inventories_-_final.pdf http://www.citeair.eu/fileadmin/Deliverables_and_documents/Guidebook_Air_Quality_Forecast_-_final.pdf)	Funding of the "GRIP for Europe Methodology", methodology described on website - GRIP provides a data mask following the methodology	In 2009, the first stage was completed resulting in the production of Greenhouse Gas Emissions inventories and Energy Baselines being produced for the participating metropolitan regions in accordance with GRIP and UN standards.
		Name of any guidance documents used/suggested	Guidebook on integrated emission inventories (also: IMACE database and IMACE guidebook) Guidebook on Air quality forecast Guidebook on mobility and exposure indicators (annexes as separate document)	InterMETREX Project Extension	Metropolitan Mitigation Measures Sourcebook
		Web address for guidance document	http://www.citeair.eu/index.php?id=24	http://www.carboncaptured.org.uk/tool.php#howToUse	http://euco2.eu/20.html
		Total Project cost	No information about total budget available.	budget of €1.16m	EUCO2 is a subproject of METREX, 2008 -2010, costs 2,2 Mio €
		Cost evaluation for cities	No information available	No information available	Climate Action Plan 2012, City of Hamburg, extra funding by the local entity about 25 Mio€.

		Cluster	Cluster 2	Cluster 2	Cluster 2
Actions	**Details**	**Project**	**Cite Air II**	**InterMETREXplus**	**EUCO2 80/50 - Metrex**
Information on policies and measures		**Is information available on implementated and/or planned policies and measures in the cities?**	Yes, "Integrated Urban Emission Inventories" (see http://www.citeair.eu/index.php?id=10)	Yes	Yes
		General description of information	Local air quality is presented like a weather forecast, presented on an interactive webpage	InterMETREX Project Extension	EUCO2 80/50, 2009, Regional Inventory Brochure
		Does the study assess the effectiveness of these measures? Quantitative? Qualitative?	With calculating of indeces between traffic and background conditions a hourly, daily and annual comparison of cities is available	Yes, offered a methodology to quantify metropolitan mitigation.	Yes, offered a methodology to quantify metropolitan mitigation.
		Does the study look at co-benefits of AQ and GHG policies?	Yes	No	No
		Does the study look at co-benefits of AQ/GHG policies with noise?	No	No	No
		Does the study link air emission inventories with an assessment of AQ in the cities covered?	Yes	No	No
		If yes, brief description of the methods used, models etc	Preparation of a local emission inventory considering AP and CO2	Yes	Yes
		Are specific 'good practices' identified? If yes, what are these?	Dissamination of Air Quality Data for europe, acessible for everyone	Yes: mainly GHG mitigation strategies like increase of public transport, share of renewable energy use, increase of energy efficency	Yes: mainly GHG mitigation strategies like increase of public transport, share of renewable energy use, increase of energy efficency
Conclusions/other		**Was there a network or 'sharing' forum set up for the cities participating in the study? If yes, details**	The internet presentation of the project allowed communication, announcement of meetings and publication of reports and scientific literature.	METREX offers a network. InterMETREXplus is presented on the webpage.	METREX offers the network platform. however,the webpage of EUCO2 80/50 presented all background information and publications.
		Was there a list of findings/conclusions from the study? If yes, summarise all main conclusions	With using the database CollectER data can be used for Air quality modelling (care was taken, that the output from the database can be fed directly into the AQ model), giving detailed AQ information; · Local knowledge is made available through the inventory, providing fresh insights in the situation; · Emissions forecasts based on industrial activity can be made; · Benchmarking across a sector of industry is possible; · Scenarios can be made with varying EFs, that reflect technology driven improvements (such as modernizing the mobile sources and the logistical techniques); · Data availability and accuracy can be a problem (historical records); · A better spatial allocation of mobile sources emissions may result in improved performance of the national emissions inventory.	With the online tool regions can compare their own energy consumption and CO2 emissions per capita. A result of several scenario workshops could be summarized that two areas where Metropolitan regions (through policy measures) could restructure their existing urban form in order to reduce emissions and increase sustainability are: - Reducing the need to travel, - Increasing opportunities to use low carbon energy.	Some key findings: 1. Only 35% of the scenarios reached the target of an 80% reduction. 2. Southern European stakeholders were less confident in mitigation chances than the rest of Europe. 3. Low Carbon Electricity generation is key to mitigation. 4. A 100% decarbonised grid would on its own reduce European CO2 emissions by less than 25%. 5. Emissions reductions in the building sector are key to mitigation. 6. Increased Industrial efficiency can contribute substantially to emissions reductions. 7. Savings in electrical energy are necessary even with a decarbonised grid. 8. Road transport is key to mitigation.

		Cluster	Cluster 3	Cluster 3	Cluster 3	Cluster 3
Actions	**Details**	**Project**	**Megapoli**	**City Zen**	**Fairmode Initiative**	**GRIP**
Overview		**Project Website**	http://megapoli.dmi.dk/index.html	https://wiki.met.no/cityzen/	http://fairmode.ew.eea.europa.eu/	http://www.carboncaptured.org.uk/
		Name and contact details of project coordinator	Alexander Baklanov, coordinator, steering group chair, Danish Meteorological Institute	Michael Gauss Norwegian Meteorological Institute P.O.Box 43 Blindern 0313 Oslo, Norway michael.gauss@met.no	Ms. Anke Lükewille European Environment Agency (EEA) Project Manager - Air Pollution, Copenhagen, Denmark email: Anke.Luekewille@eea.europa.eu & Ms. Panagiota Dilara JRC, IES, Transport and Air Quality Unit Leader of Air Quality and Transport Modelling Action, Ispra, Italy	Sebastian Carney, Tyndall Centre, The Environment Agency and METREX contact: Sebastian.Carney@manchester.ac.uk
		What are the project's objectives?	Objective 1: to assess impacts of megacities and large air-pollution "hot-spots" on local, regional, and global air quality and climate; Objective 2: to quantify feedbacks between megacity emissions, air quality, local and regional climate, and global climate change; Objective 3: to develop and implement improved, integrated tools to assess the impacts of air pollution from megacities on regional and global air quality and climate and to evaluate the effectiveness of mitigation option	• Quantify and understand current air pollution in and around selected megacities/hot spot regions • Estimate how megacities/hot spots influence climate change • Estimate how megacities are responding to climate forcing • Development of tools to estimate interactions between different spatial scales • Estimate the impact of future emission changes • Study mitigation options • Provide technical underpinning of policy work	Important objectives of the Forum for Air Quality Modelling (FAIRMODE) are: * To establish harmonised tools and methodology for enhancing communication between modellers and model users * To provide a centralised portal for information concerning air quality modelling * To establish a common infrastructure based on best practice for reporting and storing the information * To promote model validation and quality assurance of model results (deloping guidance and recommendations) to identify limitations *To support the revision of the Air Quality Directive (AQD)	The Greenhouse gas Regional Inventory Protocol in two stages: 1) production of an inventory methodology for use by the English Government Office Regions. 2) Second stage was funded by METREX on a european scale
		Who is going to perform/participate on the project?	Leading European research groups, key players from third countries to investigate the interactions among megacities, air quality and climate	16 international institutes all over Europe and Asia	European Environment Agency - EEA Norwegian Institute for Air Research - NILU Joint Research Centre - European Commission - JRC Aristotle University Thessaloniki - AUTH	University of Manchester, by Sebastian Carney PhD at Tyndall Manchester is responsible for the tool. Enables european regions to develop a compareable inventory
		What are the future prospects/follow projects?	Further updates are not planned because the project is finished. For Paris and London abatement policy was proposed.	Quantify and understand current air pollution distribution and development in and around selected megacities/hot spot regions	Put on the new air quality directive requirements, mainly on the promotion of good modelling practices and the interaction No further project planned	Online tool which provide for the European regions a consistent methodology to develop a GHG inventory.
		In what manner is the project going to be realized?	A pyramid strategy was developed of undertaking detailed measurements in Paris, performing detailed analysis for 12 megacities with existing air quality datasets and investigate the effects of all megacities on climate	Project split in four parts, WP 1: Megacities & Air Quality WP 2: Megacity/Climate interactions WP 3: Megacities in the Future: mitigation options WP 4: Integration & support to policy	Division in two working groups: Working Group 1 (WG1) of FAIRMODE: * To provide accessible guidance on the application of air quality models in regard to the European Air Quality Directive * To encourage 'good practise' with the use of models for air quality assessment and planning applications Working Group 1 (WG2) of FAIRMODE: * SG1: Monitoring and modelling * SG2: Source apportionment * SG3: Urban emissions and projections * SG4: Model benchmarking	Online inventory tool - to enable regions to compare themselves to other regions in terms of their energy consumption and emissions
		Description of study's (Projects) final deliverables	http://megapoli.dmi.dk/maininfo/delist.html	https://wiki.met.no/cityzen/deliverables	Modelling NO2 (ETC/ACM Technical Paper 2011/15), EEA technical reference guide, Model documentation System (MDS), the Delta Tool	Comparable emission inventory for each country/region taking demographic and economic data into account
		Updates planned? Update frequency?	No updates are planned because the project is finished	No further project planned	No further project planned, periodically meetings planned	Still under improvement work.
		Organisation / entitiy who is responsible for the emission inventory.	The MEGAPOLI consortium consists of 23 full partners from 11 European countries, 12 international research non-funded partners from USA, Canada, Mexico, India, Chile and Thailand, and 9 end users/stakeholders.	Emissions for Europe provided by INERtS	Working Group 2, SG 3, http://fairmode.ew.eea.europa.eu/fol404948/sg3_background_document_oct10_draft.pdf	GRIP is a webbbased tool which provides a standardized emission inventory working with input masks and statistical informations
		Project duration	(2008 - 2011)	2008 - 2011	2008 - 2012 (it is not clear if more activities are planned in future)	There is no project deadline
		Which cities were involved?	1. Level: Paris, London, Rhine-Ruhr, Po Valley; 2. Level: Moscow, Istanbul, Mexico City, Bejing, Shanghai, Santiago, Delhi, Mumbai, Bangkok, New York, Cairo, St. Petersburg, Tokyo	BeNeLux and Ruhr area • Po Valley • Eastern Mediterranean (Athinai, Istanbul, Al-Qāhirah, etc.) • Pearl River Delta (Guangzhou, Shenzhen, etc.) + Hong Kong and London	No focus on a particular city	Not only cites, but all regions of countries of EU contribute to GRIP for Europe

		Cluster	Cluster 3	Cluster 3	Cluster 3	Cluster 3
Actions	**Details**	**Project**	**Megapoli**	**City Zen**	**Fairmode Initiative**	**GRIP**
Emissions inventories at local level	**Substances**	**Pollutants included? (list) GHGs: APs:**	GHG and Air Pollutants (CO2, CH4, N2O, SF6, NOx, SOx, NH3, PM10, PM 2.5, NMVOC), the emission inventory covered only CH4, CO, NOx, SOx, NH3, PM10, PM 2.5, NMVOC	Aerosol, PM10, Ozone	All air pollutants which are considered in the air quality directive (NO2, PM, SO2, Benzene, CO, Pb, Ni, Cd, As, BaP, Ozone)	GHG emissions (CO2, CH_4, HFC, PFC, SF6, N2O)
		Noise information included?	No information concerning noise issues	No information concerning noise issues	No, only air quality information	No information concerning noise issues
		Are there activity data (e.g. local statistics, information about energy consumption) available/ used?	Air quality observation datasets and measurements, global emissions inventories to each other and to two locally-developed, citylevel inventories. Local bottom-up inventories for Paris, London, the Rhine-Ruhr area (Germany) and the Po-valley (Italy) available through the TNO ftp site to modellers within the MEGAPOLI consortium. Deliverable reports were written and available from the MEGAPOLI public website. Kuenen J., H. Denier van der Gon, A. Visschedijk, H. van der Brugh, S. Finardi, P. Radice, A. dAllura, S. Beevers, J. Theloke, M. Uzbasich, C. Honor, O. Perrussel (2010): A Base Year (2005) MEGAPOLI European Gridded Emission Inventory (Final Version). Deliverable D1.6, MEGAPOLI Scientific Report 10-17, MEGAPOLI-20-REP-2010-10, 39p.	There are air quality measurement data available, but not offically published on the internet. Furthermore, the UNECE / EMEP emission inventory was used. D.4.5.1 Report on improved emission inventories including scenarios, spatial scale-bridging model systems and the systematic observational evidence	In general no. The focus is set on a) analyzing national reported emissions or air quality parameters and for the latter scientific research was established with the aim to improve and validate modelling tools (e.g. the delta tool) on which decision making could be based.	Yes. The tool was made to collect data from Energy, Industrial Processes, Waste, Agriculture from local entities
		Is database/emissions data publicly available? If yes - address for download. If no - is it available on request?	MEGAPOLI deliverable report 1.5, Global emission inventory (final version) MEGAPOLI deliverable report 1.6, European emission inventory (final version) prepared by TNO • Beirle et al, (2011) Megacity emissions and lifetimes of nitrogen oxides probed from space, Science, 333, 1737-1739.	Emissions for Europe provided by INERIS , but restricted - requires login and emission inventory of EMEP	Compilation of Member States emission inventories of the respective Directive (National Emission Ceiling, Convention on Long-range Transboundaries, Pollutant Release Transfer Register, Large Combustion Plant Directive). Meta information (information on networks, stations and measurement configurations) and statistics for all years is available under http://acm.eionet.europa.eu/databases/airbase/query_retrieval.html (or see http://fairmode.ew.eea.europa.eu/fol/665026/data-archives). And the benchmark tool 'Delta tool': http://aqm.jrc.it/DELTA/	Yes http://www.carboncaptured.org.uk/results/
		Timeseries available?	Scenarios for 2010 to 2050 and aerosol emissions on regional climate have been conducted for the 2001-2010 decade considering base year 2005 emissions	Not published but timeseries from 1998 - 2007 used.	Data can be downloaded per country, pollutant (component) and year.	Data update per year, not in time series available.
		Data quality (TCCCA with focus on comparibility and methodology)	Global emissions inventory based on official submitted inventories from Memeber States according the UNECE/ IPCC guidelines, two locally-developed, citylevel inventories. Local bottom-up inventories for Paris, London, the Rhine-Ruhr area (Germany) and the Po-valley (Italy) - Furthermore local air quality measurements were conducted.	Data from exisisting inventories have been used and measurements has been conducted.	The information is reviewed by external review teams according the respective Guidance documents.	According IPPC Guidelines 1996 and GRIP inventory
	Sectors	**Stationary Sources (e.g. Power plants)**	Yes	Yes	Yes	Energy Industry,
		Industry and Residentials	Yes	Yes	Yes	Industrial Processes
		Mobile Sources (Transport)	Yes	Yes	Yes	Transport
		Other Diffuse Sources	Yes	Yes	Yes	Waste, Fugitive emissions,
		Agriculture	Yes	Yes	Yes	taken into account
	Guidance	**Description of methodology followed**	IPCC, UNECE reporting Guidelines, publications	IPCC, UNECE reporting Guidelines, publications	Documentation about the delta tool exists under http://aqm.jrc.it/DELTA/Publications.htm; for other emission data bases the reporting Guidelines are available under the respective link für PRTR, National emissions ceiling or Convention on long-range transboundaries. Furthermore, the Model Documentation System (MDS) should aim to provide guidance to any model user in the selection of the most appropriate model. For the Delta Tool benchmarking procedures are intended to support modelling groups in their application of AQ models in the frame of the Air Quality Directive, 2008 (AQD). The type of pollutants, period of interest and spatial scales will be determined by those required by the AQD (see here http://fairmode.ew.eea.europa.eu/models-benchmarking-sg4/wg2_sg4_benchmarking_v2.pdf).	Funding of the "GRIP for Europe Methodology", methodology described on website - GRIP provides a data mask following the methodology
		Name of any guidance documents used/suggested	Final publishable summary report MEGAPOLI Deliverable 9.6	IPCC, UNECE reporting Guidelines, publications	There is no official EEA guidance in regard to modelling but there are some suggested: * Ambient air quality, pollutant dispersion and transport models * Good Practice Guide for Atmospheric Dispersion Modelling * Guideline on Air Quality Models - Appendix W to Part 51 * Meteorological Monitoring Guide - WebMET * Modelling of Nitrogen Dioxide (NO2) for air quality assessment and planning relevant to the European Air Quality Directive see also http://fairmode.ew.eea.europa.eu/guidance-use-models-wg1 For the national emissions reporting the respective reporting guidelines (see CLRTAP & NEC, PRTR) are online available.	http://www.eurometrex.org/euco2/DOCS/Pilot/GRIP_Final_Inventory_Document_Glasgow.pdf
		Web address for guidance document	http://megapoli.dmi.dk/index.html	https://wiki.met.no/cityzen/policy_brief	http://fairmode.ew.eea.europa.eu/fol/568175/work-groups/fol429189/forums-guidance	http://www.carboncaptured.org.uk/tool.php#howToUse
		Total Project cost	Total MEGAPOLI Project Budget € 5.069.133,22	4 million €	No information available	GRIP is a subproject of METREX
		Cost evaluation for cities	No information available	No information about particular budgets	No information available	No information available

		Cluster	Cluster 3	Cluster 3	Cluster 3	Cluster 3
Actions	**Details**	**Project**	**Megapoli**	**City Zen**	**Fairmode Initiative**	**GRIP**
Information on policies and measures		**Is information available on implementated and/or planned policies and measures in the cities?**	Deliverable sr10-23.pdf; development of european emission inventory Z:\city_inventories\Megapoli\MEGAPOLI_sr10-23.pdf	In general, the study is ocused on regional scale and not on cities itseld. Brief policies were prepared to summarize main results from cityzen	Provision of a centralised portal for information concerning the AQD, submission of compliance data based on modelling, references and experiences of other users through case studies.	It includes a szenario tool which can be use to show the implications of emission mitigation
		General description of information	Several resuls which are summarized in Deliverables - PDF Documents	Publication and Deliverables - PDF Document	The main aim of FAIRMODE is to promote in a harmonised manner between member states the use of model in the context of Air Quality Assessment. Guidance Document is under preparation	Online inventory tool - standard, compareable, with uncertainties
		Does the study assess the effectiveness of these measures? Quantitative? Qualitative?	Yes. Different abatement scenarios were applied to analyze which policy options were effective to influence the emissions of AP and GHG in megacities and how these options could be assessed.	Yes. For the time period 1998 - 2007 aerosol emissions decreased.	With the DELTA tool a benchmarking service will be integrated to produce automatically reports on model performances. The content of the reports should include both quantitative and qualitative information, based on the selected core indexes and summary diagrams applied on the reduced set.	Yes, offered a methodology to quantify metropolitan mitigation measures.
		Does the study look at co-benefits of AQ and GHG policies?	Yes	Yes	Only AQ is considered.	No
		Does the study look at co-benefits of AQ/GHG policies with noise?	No	No	Only AQ is considered.	No
		Does the study link air emission inventories with an assessment of AQ in the cities covered?	Yes	Yes	Fairmode is a forum for further development of issues about the AQD. On the webpage of the EEA http://www.eea.europa.eu/themes/air/airbase air quality monitoring information is presented together with the air pollution data center. Furthermore, with the Environmental Impact Assessment (EIA) a formal study process is offered to predict the environmental consequences of a proposed project/activity, applying existing EU and National legislation and methods (see http://aix.meng.auth.gr/AIR-EIA/info.html). In the document 'Guidance document for modelling' it is mentioned (p.47) that is necessary to make independent checks of emission inventories through some form of inverse modelling method, keeping in mind that the quality of the emissions estimate using inverse modelling will not only depend on the quality of the model used but also on how well conditioned (i.e. how many similar solutions are possible) the inverse problem is.	No
		If yes, brief description of the methods used, models etc	Research focused on AQ in megacities, especially on effect of aerosols; Integrated assessment modelling methods for mesoscale-microscale coupling	Integrated assessment of modelling with using emission inventory data, satellite observations and observation side result.	There are several documents which describes the results of the different working groups (under http://fairmode.ew.eea.europa.eu/). WG1 - Guidance on use of models(lead by EEA). WG2 - Quality assurance of models (lead by JRC). SG1 - Combined use of monitoring and modelling SG2 - Contribution of natural sources and source apportionment SG3 - Urban emissions and projections SG4 - Tools for benchmarking of air quality models Furthermore, a draft document about recommendations to the EU AQ Policy is presented which included a clear statement on the necessity of a further and continuing discussion with the FAIRMODE community until an agreed final version is reached (see here http://fairmode.ew.eea.europa.eu/guidance-use-models-wg1/directive-revision/basic-recommendations-from-fairmode-to-the-review-of-the-eu-air-policy-6.docx and http://fairmode.ew.eea.europa.eu/fol429189/forums-guidance/model_guidance_document_v6_2.pdf).	No
		Are specific 'good practices' identified? If yes, what are these?	Mitigation policies for GHG described in Deliverable D3.4	The project deliverables published the different methods, but there is no good practice mentioned.	Yes, to develop a guidance document for air quality models. (See http://fairmode.ew.eea.europa.eu/fol429189/forums-guidance/model_guidance_document_v6_2.pdf; Guidance on the use of models for the European Air Quality Directive)	GRIP is a good practise itself
Conclusions/other		**Was there a network or 'sharing' forum set up for the cities participating in the study? If yes, details**	The internet presentation of the project allowed communication, announcement of meetings and publication of reports and scientific literature.	The internet presentation of the project allowed communication, announcement of meetings and publication of reports and scientific literature.	The forum is set up only for modellers and researchers and not for city contact persons (http://fairmode.ew.eea.europa.eu/fol429189/forums-guidance).	There is the so called scenario tool to show the development of cities and regions
		Was there a list of findings/conclusions from the study? If yes, summarise all main conclusions	Sitvesa European countries would not achieve the future threshold requirements of the Air Quality Directive (2008/50/EC) or the National Emission Ceilings (NEC) defined in the NEC directive (2001/81/EC), even with additional measures; the most efficient measures for improving air quality and climate change impacts by 2030 and 2050 were: - Switching to renewable heat supply in residential sector [2030/2050] - Implementing a European-wide passenger car toll [2030/2050] - Expanding electricity generation from renewables in large combustion plants [2030/2050] - Replacing solid fuel fired small combustion plants with efficient combustion techniques [2030/2050] - Replacing old gas/oil boilers with modern condensing boilers in small combustions [2030] - Implementing combined climate protection measures in the cement industry [2030] - Promoting low emission vehicles (E-cars, hybrid vehicles) [2050] Further research recommendations: - Need for "shadow" scientific emission inventories as a test-bed for new insights, delivered to modellers in a consistent manner across Europe to test their validity. - Need for periodic intercomparison and integration of emission inventories produced at different levels: Pan European inventories, member states national top-down	Megacity areas exhibit large differences in their per capita sectoral emission production leading to very particular emission patterns for each megacity. Due to a lack of monitoring sites significant gaps in data and information occur and therefore effective model evaluation and predictive capabilities are limited. Emission reduction measures proved to be efficient for ozone precursors, and should be continued.	Draft recommendations from FAIRMODE to the review of the EU Air Quality Policy (see http://fairmode.ew.eea.europa.eu/guidance-use-models-wg1/directive-revision/basic-recommendations-from-fairmode-to-the-review-of-the-eu-air-policy-6.docx): *usage of models for application of assessment of plans and measures to control AQ exceedances, *new definition of the model Quality Objectives (QO) (see Guidance on the use of models for the EU AQ), *combination of models and measurements for activities: Assessment of air quality levels and establishment of the extent of exceedances, *quality assurance of emission inventories, *definition of criteria for the future development and organization of the monitoring networks in order to ensure the availability of high quality information.	Development of a regional inventory which is comparable and support information about the uncertainty of data. Additional, a scenario tool was developed to simulate results of mitigation strategy and thus action plans tailored to regional characteristics can be developed .