Project ICT 287534
Start: 2011-09-01
Duration: 36 months
Co-funded by the European Commission within the 7th Framework Programme

SEMANCO Semantic Technologies for Carbon Reduction in Urban Planning

SEMANCO

Deliverable 2.1
Report of the case studies and analysis

Revision: 5
Due date: 2012-03-01 (m6)
Submission date: 2012-03-30
Lead contractor: CIMNE

Dissemination level		
PU	Public	X
PP	Restricted to other program participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Deliverable Administration & Summary					
No & name	**D2.1 Case Study Description**				
Status	Final	**Due**	m6	**Date**	2012-02-29
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Editor	Gonzalo Gamboa (CIMNE), in collaboration with Leandro Madrazo (FUNITEC), Tracey Crosbie (UoT).				
DoW	Assess the current situation with regard to the energy performance of the built environment within the geographical boundaries of the case studies, including: baseline of current energy consumption and CO2 emissions in the area, policy planning measures, building types, social studies. Identify the data available (distributed repositories, open data sources) to support energy efficient urban planning in the context of the demonstration scenarios. The three case studies are: - Case Study Scenario 1: Manresa, Barcelona (Spain) - Case Study Scenario 2: Newcastle Gateshead: The urban core of Tyneside (United Kingdom) - Case Study Scenario 3: The North Harbour, Copenhagen (Denmark) That is, to analyse and define the problem domain in the three selected case-study areas to provide an evidence-based understanding of the strategies required to reduce CO_2 emissions, and to focus the scope of the research on the case studies				
Comments					

Document history			
V	**Date**	**Author**	**Description**
1	2012-01-19	Xavier Cipriano, Gonzalo Gamboa (CIMNE) Joan Oliveras (FORUM) Nadeem Niwaz, Jørgen Hvid (Ramboll) David Lynch (NEA) Leandro Madrazo, Alvaro Sicilia (FUNITEC)	First version
2	2012-02-15	Xavier Cipriano, Gonzalo Gamboa (CIMNE) Joan Oliveras (FORUM) Nadeem Niwaz, Jørgen Hvid (Ramboll) David Lynch (NEA) Leandro Madrazo, Alvaro Sicilia (FUNITEC)	Second version with changes after the general review carried out in the second general meeting of the project.
3	2012-02-26	Gonzalo Gamboa (CIMNE)	Third version of the document. To be submitted for internal review.
4	2012-03-07	Gonzalo Gamboa (CIMNE) Joan Oliveras (FORUM) Nadeem Niwaz, Jørgen Hvid (Ramboll) David Lynch (NEA)	Fourth version of the document. It deals with comments and suggestions from internal reviewers. This version will be submitted for spelling revision.
5	2012-03-15	Gonzalo Gamboa (CIMNE)	Fifth version of the document. To be submitted to EU Commission

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EXECUTIVE SUMMARY

Introduction

According to the project work plan structure, Task 2.1 is intended to relate the scope of the research to the case studies. That is, to reduce the generality of the problem at stake and to link the research to real world scenarios at specific locations.

In order to do so, the report identifies ***a)*** main international policy frameworks determining urban planning and the strategies for reducing CO_2 emissions, ***b)*** the national and local policy frameworks and urban planning schemes implemented in each of the demonstration sites, ***c)*** a preliminary list of relevant actors involved in the urban planning processes and the potential users of SEIF, ***d)*** a preliminary set of expected outcomes of the analytical tools developed, ***e)*** the data requirements, the available data and the data sources providing that information. This document also reports a preliminary assessment of the current situation with regard to the energy performance of the built environment within the geographical boundaries of the case studies; thereby defining the baseline of energy consumption and CO_2 emissions at municipal level.

In general terms, the analysis of the case studies presented in this report will inform the subsequent tasks and work packages. It facilitates the definition of indicators of performance and the strategies for data modelling and data analysis (T2.2). It also identifies the different available data sources (WP3), defines the requirements for the search of adequate tools (WP5) that will be integrated with the SEIF (WP4) to support energy reduction methods in urban planning. It also delimits the scope within which decision making processes and user requirements of the tools need to be devised (WP6), involving local stakeholders in the project activities (WP7) and setting up the base for the implementation plans of the methods and tools to be created in the project (WP8).

Concepts and definitions

The issue of space and scales

There is a wide range of EU policies and directives dealing with energy consumption, energy efficiency, GHG emissions and urban planning. These EU policies are translated into policy frameworks at national and local scale, which frame energy-related policies and urban planning schemes across Member States.

This multi-scale administrative and governance system (*e.g.* administrative boundaries, responsibilities of authorities at different scales) calls for the development of multi-scale analytical approaches to unpack the complexities of the implementation of policies and plans.

At the outset of the research, it is necessary to clarify the concepts of “area” and “scale” to be adopted in the SEMANCO project. The problem of CO_2 emissions reduction (and more generally GHG emissions) is difficult to restrict to a particular geographical area. It is a systemic problem in which multiple dimensions and geographical scales need to be integrated.

With regard to the notion of “area”, we can identify two distinct approaches: one which considers space as a set of relations and the second which considers space as a container. The former might be determined by the interactions between the elements of the system and present flexible boundaries (*e.g.* the area covered by a district heating system). Space as a container is presented as an established boundary determined by administrative authority (e.g. districts/wards, cities, municipalities, provinces). However even these “static” boundaries can

be flexible and dynamic due to, for instance, legislative changes over time.

With regard to the notion of scales, we can say that the existence of multiple scales is connected with the issue of multiple dimensions of analysis. The relevant aspect necessary to represent the system differ across scales, because there are certain properties that the system has as a whole that are not possessed by any of the individual parts making up the whole, and *vice versa*. For instance, urban lighting systems are important components of the system at the neighbourhood and city levels, but they may become irrelevant when assessing and representing the energy performance of a single building. Then, there is no definitive answer if we want to assess the energy consumption per capita, and we can expect different outcomes depending on the chosen scale.

What is important to highlight is not the absence of a definitive answer to the outlined questions, but **the importance of defining the scale of analysis according to the objectives of the analysis**.

In SEMANCO, we need to integrate and make compatible the notions of space as relation and as container. Also, we should consider the consequences of dealing with systems operating at different scales in the selection of methods and tools, and of indicators of energy performance and CO_2 emissions.

Following the previous discussions held by the SEMANCO research team with regard to the notions of area and scale, we decided to adopt a broad categorisation of spatial boundaries which provides enough flexibility to be adopted by all three case studies: The **micro**, **meso** and **macro scales.**

Other definitions

The report also defines some concepts that will be used within this report and throughout the entire SEMANCO project. They are:

Data means **energy-related open data**.

Methods refer to the rules used to calculate the energy performance of buildings and places.

Tools used to assess the energy performance of buildings and places and to support decision-making in urban planning.

Actors are stakeholders in the urban planning process; they will not necessarily use tools.

Users are individuals who will be using the tools to calculate/simulate/visualise the energy performance of buildings and places.

International policy frameworks

This section briefly summarises some of the European energy and climate policies, strategies and relevant EU-directives, as well as voluntary schemes driving the objectives of energy and CO_2 savings in local urban planning schemes

European energy and climate targets and policies

There are **four** major documents that outline European energy and climate targets relevant to CO_2 reduction in urban development projects. The White Paper on Renewable Sources of Energy – COM(97)599 final – mainly promoted wind energy in order to double the share of renewable resources in the EU's gross internal energy consumption from 6% to 12% by 2010. This target was not met.

The Action Plan for Energy Efficiency – COM(2006)545 final – is aimed at reducing the EU's primary energy consumption by 20% by 2020, by means of promoting more energy efficient infrastructure, products and energy systems. Important measures are those related to energy savings, energy performance standards and labelling schemes for products, vehicles and

buildings, energy efficient power generation, coherent taxation and energy awareness.

The Climate and Energy Package, whereby the EU committed to the so-called 20-20-20 targets: by 2020, the EU should reduce its greenhouse gas emissions to at least 20% below 1990 levels, 20% of energy consumption must come from renewable resources and the use of primary energy sources should be reduced by 20% compared with projected levels.

The Roadmap for Moving to a Competitive Low-Carbon Economy in 2050 – COM(2011) 112 final – proposes a plan to reduce European greenhouse gas emissions by 80% in 2050 compared to 1990. The plan emphasises decarbonisation of the electricity sector due to the current difficulties in achieving reductions within the transport and agricultural sectors.

Relevant EU Directives

European directives provide a legislative framework enforcing national legislation and actions for greenhouse gas emission reduction.

The Energy Efficiency Directive – COM(2011) 370 final – states that the current level of action is insufficient to achieve a 20% reduction in primary energy consumption by 2020 through energy efficiency. Therefore, it proposes to broaden the scope of energy efficiency actions of the Member States to include the entire energy chain from the transformation of energy and its distribution to its final consumption.

Energy Tax Directive – 2003/96/EC – was introduced to harmonise European energy taxes and avoid competitive distortions in the energy sector within the internal market. It sets out common rules on what should be taxed as well as minimum taxation rates.

Cogeneration Directive – 2004/8/EC – was introduced to exploit the energy-saving potential in heat and power generation within the EU, mainly promoting the consolidation of existing cogeneration installations and the construction of new plants. However, the Directive does not contain any specific national targets and does not require that Member States support cogeneration.

The Directive on Energy Performance of Buildings – 2010/31/EU – aims at strengthening and improving the energy performance requirements of buildings within the European Union. It also states that the energy performance of buildings should aspire to zero carbon taking account of the potential to use renewable energy and co-generation through district heating and cooling.

Finally, the ECO directive – 2009/125/EC - promotes energy efficient appliances. Most important is electricity consuming appliances where there is a huge potential for more efficient design.

Relevant Voluntary EU Schemes and International programs

The Covenant of Mayors was launched in 2008 with the objective to promote implementation of sustainable national energy policies and advance the European 2020 targets, through the involvement of local or regional authorities. This should involve developing a CO_2 Baseline Emission Inventory (BEI) as a basis for action and submission of a Sustainable Energy Action Plan (SEAP) setting out concrete measures to reach the CO_2 target.

The Sustainable Cities Programme supports broad-based stakeholder involvement in city development strategies and encourages problem-solving through inclusive processes and pro-poor governance.

Case Study Descriptions

Denmark

National and local policy frameworks

The main national and local policy frameworks include the **Commission on Climate Change**, which proposes how Denmark would become independent from fossil fuels in 2050 by means of increasing efficiency in heating systems (heat pumps and district heating); promoting electricity as an energy carrier and wind energy as a primary energy source; and developing an intelligent energy system. The **Danish Energy Strategy 2050** states a concrete plan for achieving fossil fuel independence by 2050, following the recommendations of the Commission on Climate Change,

Strategic Energy Planning at a municipal level is a key recommendation of the Commission on Climate Change. Local authorities should first map the existing energy supply infrastructure, energy demand and resources, and then develop a strategic energy plan which is to be updated once every four years. **Strategic Heat Planning** is devolved to the municipalities, and has prioritised district heating, and to some extent district cooling.

Urban planning schemes

Since the municipal reform in 2007, the municipalities in Denmark have been given full authority over spatial planning within the framework of national regulation.

Municipalities are obliged to publish a Municipal Planning Code every four years, which should include a strategy for energy and heat supply, waste collection and treatment, including possible waste-to-energy strategies, and undertake a plan of possible wind power production within their physical area.

Also, a Local Planning Code is required in advance of any major development project or building construction or demolition project taking place. The Local Planning Code specifies the supply of district energy and stricter regulation on building energy frame.

Current situation with regard to energy performance

Much of the old building stock has undergone energy renovation (new windows, improved insulation *etc.*), and there is still in the region of a 10% margin for further reduction of heat and electricity demand. In parallel, more than 98% of all buildings are currently supplied by district heating, which are increasingly supplied by CHP plants run on biomass.

As of 2011, the city of Copenhagen released about 2,5 [Mt CO_2/y].

Description of urban planning project to be evaluated

The North Harbour development project is the largest urban development project in Scandinavia. It is located on the coast of Øresund and is only four kilometres from the centre of Copenhagen. It will be developed over the next 60 to 80 years and is intended to accommodate 40.000 residents and provide workplaces for a further 40.000 people.

The development project aims to create a CO_2 friendly city, with a sustainable supply of energy and with high priority given to public transport and cycling.

Energy use in the North Harbour will be kept at a minimum through energy efficiency measures (*e.g.* use of high energy efficient appliances and lighting systems), reducing energy use for heating and water by means of, for instance, high insulation standards, and monitoring energy use and CO_2 emissions. The North Harbour project envisages energy consumption for cooling of 37 kWh/m^2, and the use of electricity is expected to be 22 kWh/m^2 for residential buildings and 48 kWh/m^2 for office buildings.

On the supply side, the baseline of North Harbour is district heating and electricity from Copenhagen power supply along with gas. District heating and cooling is planned to cover the entire city district. In the short term, solar heating and wind energy will be used. In the long term, North Harbour will be able to use sea- and groundwater-cooling, solar energy, or geothermal heating extracted from the ground deep below the North Harbour.

Central heat pumps are another measure for district heating, and the combination with thermal energy storage could be even more attractive, with the heat pumps running when the CHP plant is standing still, hence extending the capacity of the storage facility.

There are five local solutions for the electricity production: Windmills (14,4 MW), solar pv panels with a potential of 7.000 MWh/y, micro windmills at certain locations and the city's waste incineration plant.

Four different cooling technologies are available, which individually can cover the need for cooling. The technologies are: groundwater cooling, seawater cooling, compression cooling, and absorption cooling.

It is still uncertain whether there should be established a gas supply infrastructure in North Harbour and a thermal energy storage is being considered for connection to the city's district heating system.

United Kingdom

National and local policy frameworks

The 2007 White Paper: "Meeting the Energy Challenge" set out the Government's international and domestic energy strategy to address the long term energy challenges faced by the UK, and defines four key policy goals: to cut carbon dioxide emissions by some 60% by about 2050, to maintain reliable energy supplies; To promote competitive markets in the UK and beyond; and to ensure that every home is adequately and affordable heated.

In 2008 the UK Government established the Climate Change Committee, whose first report, contained advice on the level of the first three carbon budgets and the 2050 target; this advice was accepted by the Government and legislated for by Parliament.

The UK Energy Strategy 2050, concluded that an ambitious per capita energy demand reduction is needed; a substantial level of electrification of heating, transport and industry is essential;, electricity supply may need to double and will need to be decarbonised; a growing level of variable renewable generation increases the challenge of balancing the electricity grid; and sustainable bio-energy is a vital part of the low-carbon energy system

The pathways also show an ongoing need for fossil fuels in the UK's energy mix, although their precise long-term role is still under review following a rather diluted commitment to carbon capture and storage research and development.

The UK Low Carbon Transition Plan details the medium-term actions to be taken to cut carbon emissions by 34% by 2020, based on 1990 levels. It also envisages that over 1,2 million people will be employed in green jobs, the efficiency of seven million homes will have been upgraded, 40% of electricity will be generated from low carbon sources, gas imports will be 50% lower than would otherwise have been the case and the average new car will emit 40% less carbon compared to 2009 levels.

The renewable policy framework establishes a financial framework that provides for long-term, comprehensive and targeted support for renewable technologies (*e.g.* feed-in tariffs and a Green Investment Bank). It also considers how to unblock barriers to delivery, present in the planning system, in supply chains, in the connection to the grid and in the availability and use of sustainable bio-energy. The framework also considers how to develop smart grids and

emerging technologies (*e.g.* offshore wind).

Local Policy Frameworks include the Covenant of Mayors and the corresponding action plan to deliver carbon emissions reductions in Newcastle. The Sustainable Energy Action Plan, (SEAP) sets out proposals to deliver a 20% reduction in carbon emissions by 2020 and details the scale of required interventions across 29 potential carbon reduction measures. These measures will enable the council to meet its overall targets for carbon reductions in the city.

Urban planning schemes

A Local Planning Authority (LPA), in consultation with its community, is responsible for preparing local planning policies in the form of Local Development Frameworks (LDF), which comprise a suite of documents[1] providing the policy framework to assist with the delivery of **decentralised energy generation sources**, aimed at procuring energy efficiency, energy savings or reductions in CO_2 emissions. The LDF aims to promote rather than restrict the use of renewable energy, and develops criteria-based policies to identify potentially suitable areas for renewable and low-carbon energy sources and supporting infrastructure. The LDF will reflect and enforce the Council's approach to decentralised energy proposals.

In addition, the introduction of the Localism Bill in 2011 also sought reforms designed to strengthen local autonomy. At a domestic level the local authority supports Newcastle Warm Zone (NWZ), an area-based energy efficiency programme with the primary aims of significantly reducing fuel poverty and improving energy efficiency across all of the city's households by offering free or discounted insulation and heating measures.

Newcastle City Council and Narec have set up a partnership in which Narec will assist the city council in a technical capacity to develop and deliver a sustainable energy action plan. Narec is responsible for developing an Energy Master Plan towards sustainability and carbon neutrality, managing the transition of plans and strategy, and leading on the evaluation and implementation of sustainable community energy networks through the selection of Energy Service Companies (ESCos) and other delivery vehicles.

Current situation with regard to energy performance

Newcastle's carbon footprint is approximately (Region) 1,9 Mt CO_2/y as measured in 2005 by the national indicator NI186. Calculations based on the regulator for gas and electricity markets' (Ofgem) data modelling, estimates annual baseline CO_2 emissions from the five refurbished tower blocks featured in the case study at about 517 t CO_2/y. These emissions comes from the industrial and commercial sectors (42%), the road transport sector (25%) and from the domestic sector (33%)[2]. This means the Council's operational share is approximately 3,8% (72 kt CO_2).

The Domestic Housing work stream aims to address emissions from approximately 122.000 domestic properties in Newcastle, which contribute 34% of the CO_2 generated by the city.

The annual consumption of the electrically heated properties (before intervention) has been calculated as 2,7 GWh. Whilst the existing annual energy consumption of the gas heated properties (before intervention) is estimated at 2,1 GWh.

Description of urban planning project to be evaluated

The continued redevelopment of Riverside Dene is the focus of this case study. Work started on the site back in 2009 and has now reached a key stage with five tower blocks completely refurbished and a biomass district heating system installed providing domestic heating and hot

[1] The local development scheme (LDS), the development plan documents (DPDs), the supplementary planning documents (SPDs), the statement of community involvement (SCI) and the annual monitoring report (AMR).

[2] The carbon footprint figures for Newcastle upon Tyne mainly include emissions from gas and electricity use and road transport fuels. They exclude emissions from motorways, shipping and aviation and those covered by the EU Emissions Trading Scheme.

water.

Future potential works include demolition of the remaining un-refurbished tower blocks and disposal of the land for residential and/or mixed use, the redevelopment of Cruddas Park Shopping Centre and extensions of the biomass system to any new developments in Riverside.

The demolition of the five remaining tower blocks gives rise to questions on to what will be done with the land and the future impact on local energy requirements. Clearly there is potential to model various scenarios based on residential and mixed use propositions.

Energy use, and associated emissions, across the Riverside Dene development have been kept to a minimum by installing biomass district heating, and high efficiency insulation and lighting systems

The project also anticipates the installations of smart heat meters in all of the dwellings

In relation to energy supply options, the plan considers development of centralised gas or biomass-fired combined heat and power units, delivered through Energy Services Companies (ESCos).

There are four relevant sustainable local solutions for electricity production which will form part of this case study: windmills, solar PV panels, micro-windmills and biomass.

Spain

National and local policy frameworks

The National Energy Savings and Efficiency Action Plan aims to improve the final energy intensity by an annual decrease of 1,5% between 2010-2020 in order to save 20% of primary energy consumption (compared with non-implementation of the plan).[3] The main programmes of the NEEAP are the Energy Efficiency in Public Buildings Activation Plan and the Plan for the Support of Energy Service Contracts. Both programmes support the Energy Services Enterprises (ESE) to implement energy saving measures in public buildings.

The plan considers the actions in different sectors. Most of the savings will be obtained in Industry and Transport, accounting for 25% and 50% of the whole projected savings respectively. The plan considers how best to foster technological improvement and the implementation of energy management systems in the industrial sector, and the promotion of passenger and freight trains and private car and fleet freight renewal along with the development of urban mobility plans in the transport sector

The Renewable Energy Plan (2012-2020) promotes improvements in energy savings and energy efficiency, and the promotion of renewable energy sources. Most of the budget is allocated to electricity generation in order to increase the share of renewable electricity to approximately 40%, mainly through promotion of wind power.

The plan defines a set of legislative, economic and technical instruments to promote the use of renewable energy sources. Also, the plan includes actions relating to electricity infrastructure, natural gas networks and bio/agro-fuels and hydrocarbon logistics.

The building and facilities sector has the greatest potential for developing energy saving and efficiency projects. The Technical Code of Edification deals with occupancy and energy, establishing norms and procedures to fulfil basic requirements for energy saving in new buildings: it limits energy demand; defines the minimum performance of thermal installations; and defines the energy efficiency of lighting installations, among other measures. The Code

[3] The plan envisages an annual growth rate of 2,3%, which would imply a increase of primary energy consumption of 20,8% if the plan is not implemented.

defines the energy accreditation and qualification framework and the energy certification process, and the accredited control organisms and independent qualified technicians carrying out the qualification and certification tasks.

Urban planning schemes

Urban development is a highly decentralised activity and the Autonomous Communities[4] have a very important role. In the case of Catalonia, it is the Department of Territory and Sustainability of the Catalonian government that approves (or rejects) all territorial ordering plans at the level of the community. Also, the Catalan government has control of the development of landscape guidelines and coastal protection law. The legal framework regulating these processes is the Urban Planning Law, which is implemented by a number of different instruments:

The **Territorial plans** define the objectives of the different parts of the Catalonian territory. **Urban Master Plans** establish guidelines to co-ordinate the urban ordering process within a supra-municipal territory. They determine the requirements of sustainable urban development, the mobility of people and freight and public transport, among other responsibilities.

Catalan municipalities enjoy a high degree of autonomy in the development of the city planning model. In order to do so, the following planning mechanisms are utilised: **General Plans of Urban Ordering** (PGOU) that categorise municipal territory into urban land, building land and land protected from urban development. The **Derivative plans** (Partial plans and Special plans) that implement the definitions of the general plans in a defined ambit or planning sector classified as urban land or building land.

Current situation with regard to energy performance

During recent years, the consumption of electricity has been constantly increasing, reaching a level of some 440 GWh in 2006. The consumption of liquid fuels shows an increasing trend (about 590 GWh), and the consumption of natural gas seems to stabilise at about 460 GWh.

Regarding greenhouse gas emissions, the whole municipality emits about 465,5 [Kt CO_2 eq/year], which equates to 6,5 [ton CO_2 eq/year] per capita. However, these figures should be subject to corroboration since there are some doubts regarding the correct application of calculation protocols.

Unfortunately, information is available only at the municipal level. There is no data at neighbourhood or building level. However, FORUM and CIMNE, both partners in this project, have implemented energy monitoring projects aimed at collecting information on energy consumption in social housing and public buildings respectively.

Description of urban planning projects to be evaluated

The aim of the case study is to validate the application of SEMANCO methodologies and tools (SEIF), at least at building and neighbourhood levels. Also, the case study considers the use of SEIF to assess the energy performance and CO_2 emissions of projected urban plans at city level.

Validation of SEIF: In a first phase, we will validate SEIF in the *Casc Antic* district (the old town of the city). At the **building level**, we will analyse the performance of six blocks of public housing (220 dwellings, mostly of new construction) and of two refurbished public buildings. In order to do so, CIMNE and FORUM have obtained detailed monitoring data and

[4] Autonomous Community (*comunidad autónoma*) is the first-level political division in Spain established in accordance with the current Spanish Constitution. The second article of the constitution recognises the rights of nationalities and regions to self-government.

information on energy saving measures in 108 dwellings; it is also possible to obtain historical monthly energy consumption relating to 60 dwellings constructed about the year 1970 where no energy-saving measures have been implemented. Regarding public buildings and facilities, monthly energy consumption of 157 public buildings from a remote energy information system (SIE) is available, as well as energy audit information covering 35 of these buildings.

The analysis at the **neighbourhood level** requires the definition of some building typologies and their special distribution. Typologies are based on the structural characteristics of the buildings, their use (residential, public, offices) and socio-economic characteristics of their occupants. These building typologies will be used to up-scale energy consumption analysis from the building scale to the neighbourhood scale. The description of building typologies will consider the energy carriers used (and their amount) and final uses within the building.

Assessment of projected urban plan: In a second phase, we consider the application of SEIF to assess the scenarios of energy consumption and CO_2 emissions at building, neighbourhood and city levels (*i.e.* urban area) levels. Scenarios will be developed that fit the future general urban plan of the city. The energy calculations will be based on building typologies and energy simulations of the different sectors and different energy sources available. There are additional potential future scenarios, including the implementation of local energy production schemes, construction of energy networks and/or the simulation of changes in behaviour and lifestyle

Actors and users

Each case study has defined a list of potential actors and users. They comprise national and local authorities, private companies, public facilities and the general public. A preliminary list of actors and users is provided in Appendix B of the document including the description, the scales of action, the relevant urban planning schemes and their role.

Output analysis and data requirements

Each case study has identified a preliminary list of expected outcomes, which includes: the demand for final energy use; the demand for different energy carriers; the CO_2 emissions and reduction compared to baseline; the share of energy carriers from renewable energy sources; the share of local energy carriers; the cost of supply of final energy uses; the cost of implementation; and social inclusion and cohesion factors (See Appendix C). Also, it has been possible to define a preliminary set of potential indicators for each of the expected outcomes listed above.

Available data sources

In this report, each case study has performed a preliminary identification of the data sources required to carry out an assessment of the expected outcomes. Appendix D presents detailed information on the nature of the available data sources.

Conclusions

Contribution to overall picture

The present document focus the scope of the research on the case studies as a means of identifying practical strategies to reduce CO_2 emissions via urban planning linked to real world scenarios. The report provides the information required to reduce the generality of the problem addressed. It does so by describing the main international policy frameworks determining urban planning, the strategies for reducing CO_2 emissions and the national and local policy frameworks and urban planning schemes. It presents a preliminary identification of relevant actors involved in the urban planning processes and the potential users of SEIF. The report also presents a preliminary introduction to expected outcomes of the analytical

tools developed, the data requirements and the available data and data sources and the baseline of energy consumption and CO_2 emissions at municipal level.

Impact on other WPs and Tasks

Overall, Task 2.1 provides valuable information to support the planned activities in the other WPs. It provides preliminary information on the potential actors and users to be incorporated in WP6 for the development of scenarios. It also defines a preliminary list of expected outcomes, which frames the development of strategies and indicators for data modelling and data analysis (T2.2). It identifies the available data sources and the required data to be processed in WP3 and determines the preliminary requirements of tools and methods for energy and CO_2 emissions analysis (WP5), which will be integrated with the SEIF (WP4).

Contribution to demonstration

The report has produced valuable information that contributes to the demonstration phase of SEMANCO. It provides a preliminary description of interventions and strategies to reduce CO_2 emissions, considered within each case study and assessed in subsequent tasks.

It describes the international and national policy frameworks and urban planning schemes, which gives us a preliminary view of the conflicting social, economic, political and environmental constraints within planning and design practice to support stakeholder decision-making.

It also provides a preliminary overview of baseline energy consumption and CO_2 emissions in each demonstration scenario, which will allow comparison of potential patterns of growth and urban developments which reduce energy consumption and CO_2 emissions.

Other conclusions and lessons learned

The report states that the definition of the scales of analysis is context-dependent and should be defined according to the problem at hand and to the purpose of the analysis. Therefore, the report defines three general categories of analytical scales: the **micro**, **meso** and **macro** scales.

It finishes by highlighting the fact that the existence of multiple scales of analysis entails important consequences in the processes of perceiving and representing the system: an issue that should be seriously considered in subsequent tasks defining the methods and tools to be used for the calculation of energy performance and CO_2 emissions, and the need to define adequate methodologies to check the validity of calculations across scales.

1.INTRODUCTION

1.1 Purpose and target group

According to the project work plan structure (figure 1), the SEMANCO research begins by delimiting the scope of the project to the case studies. This methodology enables us:

1. To reduce the generality of the problem at stake, by means of identifying tangible strategies to reduce CO_2 emissions via urban planning linked to real world scenarios and the semantic-based tools required to support them
2. To demonstrate these strategies and semantic-based tools in specific real locations.

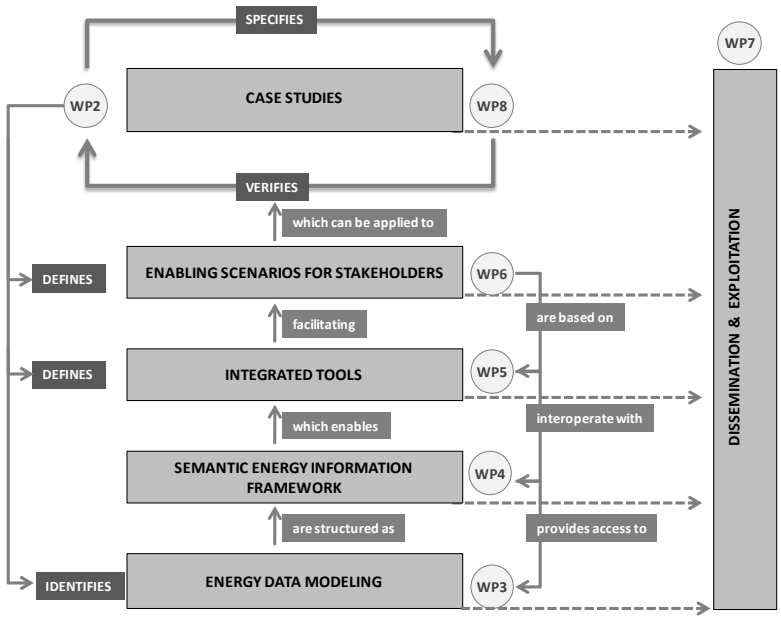

Figure 1. Structure of the WP and their interrelationships

As it is described in the DoW, the objective of WP2 is "*to analyse the problem domain in the three selected case-study areas to provide an evidence-based understanding of the strategies required to reduce CO_2 emissions.*"[5]

Within this context, the purpose of Task 2.1 is *"to assess the current situation with regard to the energy performance of the built environment within the geographical boundaries of the case studies."*[6] This means that, among other things, this report seeks to identify existing policy planning measures, the stakeholders in the implementation of these measures, and the available data sources which taken together delimit the scope of the research.

In accordance with the goals previously described, this report addresses the following:

- The main international policy frameworks determining urban planning and the strategies for reducing CO_2 emissions.
- The National and Local policy frameworks and the urban planning schemes

[5] DoW, p. 8

[6] Ibíd

implemented in each of the demonstration sites.[7]

- A preliminary identification of the relevant actors involved in the urban planning processes and the potential users of SEIF.[8]
- A preliminary assessment of the current situation with regard to the energy performance of the built environment within the geographical boundaries of the case studies; defining the baseline of energy consumption and CO_2 emissions at municipal level.

This report is supplemented with more information about each of the case studies provided in Appendices. This document details the urban planning schemes, relevant actors and users, expected outcomes and data requirements, applicable legislation and available data sources for each case study. This information has been compiled in tables to facilitate understanding as well as the comparison between the three cases.

1.2 Contribution of partners

This report was written by the partners responsible for each case study with the collaboration of the project coordinator.

Specifically, the review of international policy frameworks was conducted by Ramboll. The description of each case study was undertaken by the following partners: North Harbour, Copenhagen, by Ramboll; Newcastle, United Kingdom, by UoT and NEA; and Manresa, Spain, by CIMNE and Forum.

The collation of the information and the editing of the document were performed by CIMNE in collaboration with the coordinator.

Detailed reviews of the deliverable were conducted by UoT and Polito and the final version of the report was proofread by staff at the NEA.

1.3 Relations to other activities in the project

In general terms, the analysis of the case studies presented in this report will inform subsequent work packages by identifying the different available data sources (WP3) and the existing tools (WP5) which can be integrated with the SEIF (WP4) to support energy efficient urban planning. This analysis also enables us to delimit the range of decision-making process within the urban planning domain and the user requirements of the tools to be developed (WP6), it provides a preliminary list of local stakeholders to be involved in project activities (WP7) and it frames the implementation plans of the methods and tools to be demonstrated in the project (WP8).

Figure 2 illustrates which of the outputs of D.2.1 are inputs to subsequent tasks and deliverables in WPs 2, 3, 4, 5 and 6.

[7] National and Local policy frameworks are the translation of the international frameworks at the Member State level, and urban planning schemes frame urban developments and determines its corresponding energy and emissions performances.

[8] The objectives of those actors and users (expressed through the expected outcomes of the analytical tools developed) determine the scope and the domain of SEIF; which in turn determines the data requirements, the available data (distributed repositories, open data sources) to support energy efficient urban planning in the context of the demonstration scenarios, and the data sources providing that information

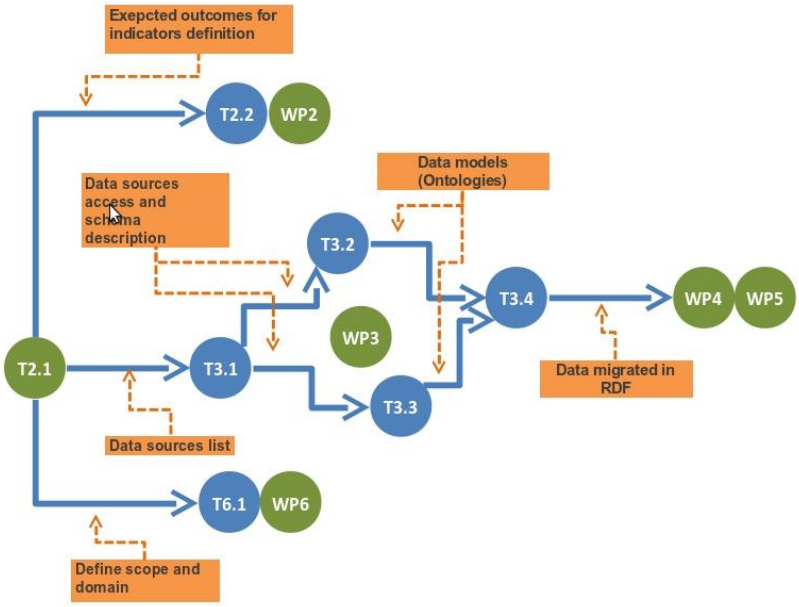

Figure 2. Flows of information across Tasks and Work packages

As detailed in figure 2 the work underpinning D2.1 will:

- Facilitate the definition of performance indicators and the strategies for data modelling and data analysis (T2.2);
- Provide information about the data sources required for T3.1;
- Provide information about potential actors and users and their expected outcomes to be used in T.6.1 to define the scope and domain of SEIF;
- Provide information about the analytical capabilities of existing tools and the gaps in those capabilities (WP5).

Altogether, the information provided in this report will help to identify who will use the methods and tools under development to conduct what types of analysis using which data.

2 CONCEPTS AND DEFINITIONS

This section provides some important definitions to be used within this report and throughout the entire SEMANCO project.

First, the section deals with the issue of the analytical scales to be considered within SEMANCO. The document highlights the complex task of defining the scales of analysis and the implications of those pre-analytical decisions. Subsequently, this section defines concepts such as data, methods, tools, actors and users.

2.1 Defining the scales of analysis

As we will see in the following sections, there are a wide range of EU policies and directives dealing with energy consumption, energy efficiency, greenhouse gas (GHG) emissions and urban planning. These European policies and directives set the framework in which national and local authorities have to develop and implement their own policies and plans. As we will see in the description of each national context – in Denmark, the UK and Spain – there are several energy-related policies and urban planning schemes heavily influenced by European policies and directives dealing with climate change and energy consumption. Moreover, each country has defined the scope of these national and local policies and planning schemes according to their specificities regarding the internal multi-scale administrative and governance systems (*e.g.* administrative boundaries and the responsibilities of authorities at different geographical scales). As described in the DoW, *"[i]n order to address the multiple dimensions involved in the problem of CO_2 emission reduction, the tools and methods developed in this project will integrate the neighbourhood , municipal and regional scales"*.[9] To support both the implementation of different urban planning schemes and to respond to the requirements of different stakeholders involved at different decision-making levels (multi-level administrative and governance schemes) it is necessary to develop multi-scale analytical approaches to unpack the complexities of the implementation of policies and plans.

2.1.1 Preliminary reflections

At the outset of the research, it is necessary to clarify the concepts of "area" and "scale" to be adopted in the SEMANCO project. The problem of CO_2 emissions reduction (and in general with GHG emissions) is difficult to delimit to a particular geographical area. It is a systemic problem in which multiple dimensions and geographical scales need to be integrated.[10] The existence of multiple scales is connected with the issue of multiple dimensions of analysis. When we describe the system at different scales (*e.g.* the urban system described at the level of building, neighbourhood, district, city, municipality) the relevant aspects for the analysis may differ across levels. A system has certain properties and behaviours that are not possessed by any of the individual parts making up the whole. The opposite also applies: there are emergent properties of the parts which conform to the whole that are not possessed by the system as such. For instance, urban lighting systems are important components of the system at the neighbourhood and city levels. At these levels, the energy accounting system should consider the energy consumption of the lighting systems, which may become irrelevant in the analysis of the energy performance of a building. Also, the requirements of human, economic and technical resources are covered at the neighbourhood and city level by, for instance, a municipal company.

How then can we define the concepts of "area" and "scale" within the SEMANCO research? With regard to the notion of "area" we can identify two distinct approaches to the notion of

[9] DoW, p. 8.

[10] Incidentally, a similar problem arises with regard to the relationship between the EU policies and their implementation at the local levels, which represent different dimensions within an overall system.

space: one which considers space as a set of relations and the second which considers space as a container. In figure 3, the former is represented by a dynamic flexible boundary which might be determined by the interactions between the elements of the system (between data, between stakeholders, between factors influencing CO_2 emissions). Space as a container is presented as an established boundary determined by administrative reasons (a neighborhood, a county or a region etc. see the right side of figure 3). In this case, what is a regional boundary or a municipal boundary can vary from country to country.

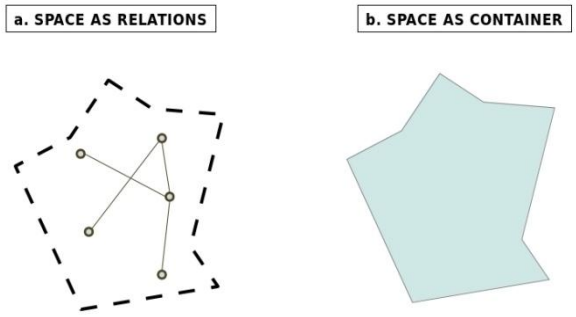

Figure 3. Understanding the space as relations or as container (Source: Own elaboration)

On the one hand, we have areas and regions with dynamic and flexible limits; limits that are determined by the interactions between identified elements of the system (*e.g.* the system by which the problem of CO_2 reduction is conceptualised).[11] On the other hand, there are areas and regions that have established limits, such as administrative regions. These areas/regions are also decision-making domains, for instance, at the political and administrative levels. This is the case for districts/wards, cities, municipalities, provinces and so on. However even these "static" boundaries can be flexible and dynamic. For instance, laws and policies defining boundaries of action may change over time: new laws may redefine the administrative boundaries, and urban planning schemes may change their conception of spatial scales to incorporate these changes. In SEMANCO, we need to integrate and make compatible both notions of space.

2.1.2 Additional considerations

To understand the implications of the integration of both notions of space, the example provided by Giampietro (2004) is useful, see figure 4 which poses the question which is the orientation of the coastal line of Maine? According to Giampietro (2004) there is no definitive answer to the question about the orientation of the coastline of Maine, as the answer depends on the pre-analytical decision about the scale of the analysis. For example, if our objective is to make a call from Maine to California we will choose the level of whole country (see figure 4a), on the other hand if our intention is to buy a house on the beach we will choose the village level (see figure 4d) so that we can decide if we will we see the sunrise over the beach from our new home.

[11] For instance, an area defined by the coverage of the district heating system, in which each building is considered as a node and the size of the system may change according to expansion works.

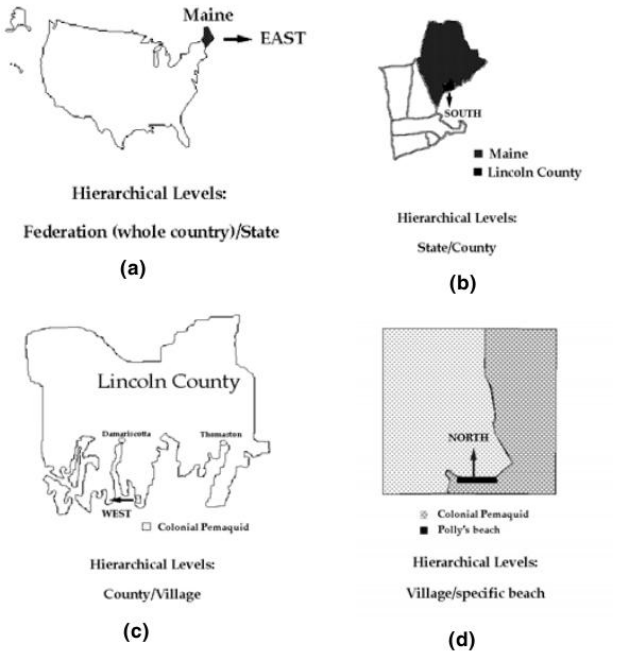

Figure 4. Which is the orientation of the coastal line of Maine? (Source: Giampietro 2004)

In other words, the identity of the system under analysis depends on the scale of analysis. In the example of lighting systems, we can expect different values for the electricity consumption per capita if we carry out the calculation at building or city levels (also see Sorman and Giampietro, 2011). What is important to highlight is not the absence of a definitive answer to the outlined questions, but **the importance of defining the scale of analysis according to the objectives of the analysis**.

We should consider the consequences of dealing with systems operating at different scales in the selection of methods and tools, and of indicators of energy performance and CO_2 emissions. On the one hand, the chosen methods and tools should generate coherent outcomes across scales. On the other side, we should define different and adequate indicators at different scales to assess the performance of the system in terms of energy consumption, CO_2 emissions, social well-being, among other dimensions of analysis.

2.1.3 Conclusions

Following the discussions held by the SEMANCO research team with regard to the notions of area and scale, we have decided to adopt a broad categorisation of spatial boundaries which provides enough flexibility to be adopted by all three cases of study:

- The **micro scale**, which encompasses analysis at the building level, this could be a single household, a residential building of multi-occupation,[12] an office building or a public facility.
- The **meso scale**, such as a district, a ward, a neighbourhood or a city. In the last case, we consider a city as the main urban area of a municipality, excluding the industrial zones and rural areas.
- The **macro scale** defined as an area or region beyond the city. That is, the municipality (*e.g.* urban, rural and industrial areas), the province or some other aggregation of the

[12] A residential property where 'common areas' exist that are shared by more than one household. Common areas may be as significant as bathrooms and kitchenettes or be merely stairwells or landings. These types of properties can be divided up into self-contained flats, bed-sitting rooms or simple lodgings.

meso-scale categories.

2.2 Other definitions

The following concepts will be used within this report and throughout the entire SEMANCO project.

Data means **energy-related open data**. Data is open if anyone is free to use, reuse, and redistribute it. Energy-related data includes: location of buildings, building specifications, weather data, energy load and electricity and gas consumption. It may also include data about pollution and socio-economic metrics such as income, to help stakeholders place energy and CO_2 reduction planning within particular problem domains.

Methods refers to the rules used to calculate the energy performance of buildings and places. This includes methods of simulating the impact of different interventions to reduce CO_2 emissions in the built environment and methods of calculating performance indicators.

Tools used to assess the energy performance of building and places and to support decision-making in urban planning. This includes existing and new tools –both integrated in the SEIF–to simulate, calculate and visualise the impact of different interventions to reduce CO_2 emissions in the built environment.

Actors are stakeholders in the urban planning process such as local and national policy makers, building developers, housing providers and property companies, or a person, group or organisation that affects or can be affected by an urban plan or policy. These actors are not, however, necessarily those that will use the tools to calculate/simulate the energy performance of buildings and places.

Users are individuals who will be using the tools to calculate/simulate/visualise the energy performance of buildings and places. These could be analysts working in municipal planning departments, consultancy companies or social housing providers.

The next section describes the main international policy frameworks determining national and local energy-related policy frameworks, and thus, determining urban planning schemes and the strategies for reducing CO_2 emissions at national and local levels.

3 INTERNATIONAL POLICY FRAMEWORK

This section briefly summarises European energy and climate change policies, along with strategies and relevant EU-directives. It also describes some voluntary schemes driving the objectives of energy and CO_2 reduction in urban planning in general and, more specifically, in the three case studies.

To develop SEMANCO's tools and methods, it is first necessary to outline the political framework that informs the objectives and strategies for CO_2 reduction in each of the case studies. The context in which stakeholders (actors and users) and decision-makers operate within each case study is determined by the policy framework set up at the European, national and local levels. The following section summarises the most important policies guiding urban development and the related energy efficiency schemes at the European level. National and local policies for each case study are summarised in the later sections of this report.

3.1 European energy and climate targets and policies

The following four major documents outline European energy and climate targets relevant to GHG emissions reduction in urban development projects:

3.1.1 White Paper on Renewable Sources of Energy [COM(97)599 final]

In 1997, the European Commission published the "White Paper on Renewable Sources of Energy". The objective of the paper was to promote a doubling of the share of renewable resources in the EU's gross internal energy consumption from 6% to 12% by 2010. Over the period 1999-2009 the energy statistics from Eurostat show that the renewable energy sources for EU-27 rose from 3,5 percentage points to only 9.0 %. Hence, the target of this paper was not met

Two core targets were to install 40.000 MWh wind power capacity, and to increase the share of electricity from renewable sources to 675 TWh by 2010. The 40.000 MWh wind power was installed by 2005, while 605 TWh of electricity were produced from renewable sources in 2009.

3.1.2 Action Plan for Energy Efficiency [COM(2006)545 final]

The purpose of the plan is to have the internal energy market provide more energy efficient infrastructure, products and energy systems. The objective is to reduce the EU's primary energy consumption by 20% by 2020.

The plan proposed a number of measures to be implemented between 2007 and the end of 2012. Particularly important measures were: energy savings; energy performance standards and labelling schemes for products, vehicles and buildings; energy efficient power generation; coherent taxation; and energy awareness. Specific actions included the creation of the Covenant of Mayors.

Member states committed to submit national energy efficiency action plans to the EU executive under the Energy End-Use Efficiency and Energy Services Directive (2006/32/EC). As of 2011, an Energy Efficiency Plan was adopted and translated into an Energy Efficiency Directive, which points at the Smart City initiative (smart grids, district heating and cooling, and natural gas).

3.1.3 Climate and Energy Package (2007)

The European plan to combat climate change became law in June 2009, whereby the EU committed to the so-called 20-20-20 targets (EC, 2010):

- A reduction in greenhouse gas emissions of at least 20% below 1990 levels by 2020
- 20% of energy consumption must come from renewable resources by 2020
- A 20% reduction in primary energy use compared with projected levels, to be achieved by improving energy efficiency by 2020

The climate and energy package consists of four legislative texts: a Directive revising the EU Emissions Trading System (EU ETS); the Effort-Sharing Decision setting national targets for transport, housing, agriculture and waste; a Directive setting binding national targets for the share of renewable energy sources in the energy mix; and a Directive creating a legal framework for the use of carbon capture and storage technologies.

3.1.4 Roadmap for Moving to a Competitive Low-Carbon Economy in 2050 [COM(2011) 112 final]

Published on the 8th of March 2011, the Roadmap for moving to a low-carbon economy in 2050 proposes a plan to reduce European GHG emissions by 80% in 2050 compared to 1990. This target for carbon reduction is built on meeting an annual carbon reduction target which increases over time: 1% up to 2020, 1,5% between 2020 and 2030, and 2% between 2030 and 2050. Due to the current difficulties in achieving carbon reductions in the transport and agricultural sectors, the proposed plan emphasises the decarbonisation of the electricity sector. It proposes that renewable energy sources of electricity production are increased from 45% to 60% by 2020 and then increased to 80% by 2030 with a final goal to reach100% in 2050 (EC 2011a).

3.2 Relevant EU Directives

This section contains a summary of relevant European directives which provide a legislative framework enforcing national legislation and actions for greenhouse gas emission savings:

3.2.1 Renewable Energy Directive. On the promotion of the use of energy from renewable sources (2009/28/EC)

From 1 January 2012, the Directive 2009/28/EC replaces Directive 2001/77/EC (on the promotion of renewable energy sources) and Directive 2003/30/EC (on the promotion of the use of biofuels or other renewable fuels for transport). It was introduced to facilitate European production and promotion of energy from renewable sources. It sets out national targets for each Member State for the share of renewable energy in the gross final consumption for 2020. Furthermore, it states that the share of renewable energy in the transport sector must be at least 10 % of final energy consumption by 2020.

It is the basis for the development of National Action Plans that determine the share in 2020 of renewable energy consumed in transport and in the production of electricity, heating and cooling. The Action Plans must also establish procedures for reform of planning and pricing schemes and access to electricity networks, promoting energy from renewable sources. Also, Member States must provide a guarantee of the origin of electricity, heating and cooling produced from renewable energy sources, and should build the necessary infrastructure to utilise renewable energy in the transport sector.

Hence, the renewable energy targets from previous Directives regarding electricity production and bio-fuels in the transport sector have now been transformed into renewable energy targets in general covering electricity and heating as well as the transport sector towards 2020.

3.2.2 Energy Tax Directive. On restructuring the Community framework for taxation of energy and electricity (2003/96/EC)

The Directive 2003/96/EC was introduced to harmonise European energy taxes and avoid competitive distortions in the energy sector within the internal market. It sets out common rules on what should be taxed as well as minimum taxation rates. The memo of the European Commission (MEMO/11/238) suggested basing the minimum taxation rates according to carbon dioxide (CO_2) emissions and the energy content of the fuel that is consumed, instead of on consumed volume of energy.

3.2.3 Cogeneration Directive. On the promotion of cogeneration based on a useful heat demand in the internal energy market (2004/8/EC)

The Directive 2004/8/EC was introduced to exploit the energy-saving potential in heat and power generation within the EU. Its aims are to make possible the consolidation of existing co-generation installations and promote new plants, and create the necessary framework for high efficiency co-generation, upon which the member states could base their national legislation. It also promotes the identification of barriers and their removal. However, the Directive does not contain any specific national targets and does not require that the Member States support co-generation.

3.2.4 Directive on Energy Performance of Buildings (2010/31/EU)

In 2010, a recast of the Energy Performance of Buildings Directive (2002/91/EC) was adopted to strengthen the energy performance requirements of buildings. The overall objective of the directive is to promote the improvement of the energy performance of buildings within the European Union, taking into account outdoor climatic and local conditions, as well as indoor climate requirements and cost-effectiveness. It also states that buildings shall be nearly zero carbon taking account of the possibility of using renewable energy and co-generation through district heating and cooling

The recast Directive establishes that new buildings must consume "nearly zero-energy" by 2020 (ECEEE 2010). Buildings shall be nearly zero taking into account that it can be much more cost effective to transfer surplus heat from cogeneration and renewable energy to the buildings via district heating and cooling. This is fully in line with the requirements in the Renewable Energy Sources (RES) and Energy Efficiency (EE) directives that state that local and regional authorities shall plan an urban infrastructure for district heating and cooling wherever it is more cost effective than individual sources.

3.2.5 Energy Efficiency Directive [COM(2011) 370 final]

This proposal is based on the European Commission's energy efficiency plan from March 8th 2011. It shows that the current level of action is insufficient to achieve a 20% reduction in primary energy consumption by 2020 through energy efficiency. The proposed Energy directive is expected to replace Directives 2004/8/EC on Cogeneration as well as Directive 2006/32/EC on Energy End Use Efficiency and Energy Services. The proposed directive broadens the scope of energy efficiency actions of the Member States to include the entire energy chain from the transformation of energy and its distribution to its final consumption.

It includes an important measure for promoting an efficient energy sector *i.e.* that new power capacity shall be established as CHP (Combined Heat and Power) plants. However, the cost-effectiveness of such urban energy infrastructure must be secured by means of national district heating and cooling plans.

3.2.6 ECO directive (2009/125/EC)

The aim of this directive is to promote energy efficient appliances. Priority is given to electricity consuming appliances where there is a huge potential for more efficient design, *e.g.* low-energy electronics, small stand-by losses, use of hot tap water instead of electricity for washing- and dish-washing machines.

3.2.7 CPR – Construction Products Regulation

The aim of this regulation is to ensure reliable information on construction products in relation to their performances. The basic requirements of the construction works include "Energy economy and heat retention", according to which the construction works and their heating, cooling, lighting and ventilation installations must be designed and built in such a way that the amount of energy they require in use shall be low, when account is taken of the occupants and of the climatic conditions of the location; and construction works must also be energy efficient, using as little energy as possible during their construction and dismantling

3.3 Relevant Voluntary EU Schemes and International programs

3.3.1 Covenant of Mayors

The Covenant of Mayors was launched in 2008 with the objective to promote implementation of sustainable national energy policies and advance the European 2020 targets, through the involvement of local or regional authorities. By signing the Covenant, signatories commit to reduce CO_2 emissions within their territories by at least 20% by 2020, and to document their efforts in a Sustainable Energy Action Plan. In order to do so, the local administration should develop a CO_2 Baseline Emission Inventory (BEI), as a basis for action, submit a Sustainable Energy Action Plan (SEAP) with concrete measures to reach the CO_2 target and submit implementation reports at least every second year after the SEAP, for evaluation, monitoring and verification. By December 2011, the Covenant had 3.155 signatories.[13]

In the three case studies considered in SEMANCO all local authorities have signed the Covenant.

3.3.2 The Sustainable Cities Programme

The Sustainable Cities Programme (SCP) is a joint UN-HABITAT/UNEP facility established in the early 1990s to build capacities in urban environmental planning and management. The programme targets urban local authorities and their partners. It is founded on broad-based stakeholder participatory approaches. Its sister programme Localising Agenda 21 (LA21) operates in over 30 countries worldwide.

The programme supports broad-based stakeholder involvement in city development strategies and problem-solving through inclusive processes and pro-poor governance.

In the next section this report turns to the question of how the directives, policies and voluntary agreements at the European level presented above are translated into implementation in each of the case study domains. It presents the national and local policy frameworks, and the urban planning schemes affecting each one of the cases of study (*i.e.* defining the objectives of energy and CO_2 reduction in urban planning). Each case study presents the urban plan or project in which SEIF will be implemented, identifying the problem at hand and the objective of the analysis, which is of fundamental importance in order to define the scales of analysis. Finally, the report provides a preliminary identification of available information and data sources to be semantically modeled within SEMANCO.

[13] Covenant in figures at http://www.eumayors.eu/about/covenant-in-figures_en.html

4 CASE STUDY DESCRIPTIONS

4.1 Denmark

4.1.1 National and local policy frameworks

4.1.1.1 Commission on Climate Change

In March 2008, the Danish Government appointed a Commission on Climate Change to propose how the Government's vision of Denmark becoming independent from fossil fuels in 2050 could be achieved in practice.

In September 2010, the Commission presented its recommendations in the "Green Energy" report, which was used as the basis for the Danish Energy Strategy 2050 which came into force in February 2011. The main points are (Danish Commission on Climate Change Policy 2010):

- Energy will be used far more efficiently, so for example we can heat our houses using half the energy we use today, and drive our cars further on the same amount of energy
- Electricity will play a much bigger role in the energy system. A total of 40%-70% of energy consumption will be met by electricity, compared to 20% today;
- Off shore wind turbines will be the back bone in the coming energy system. We will have to erect many more turbines to cover up to half of Denmark's energy consumption;
- The energy system will be intelligent. The dominance of wind power in the energy system requires that the electricity consumption becomes more flexible. Intelligent electricity meters, time-controlled recharging for electric cars and heat pumps in combination with heat storage systems are some of the technologies required. In addition, international electricity links must be expanded;
- Biomass will play an important role in the coming energy system, not least in the transport sector and as a backup for wind turbines;
- Houses will be heated with electric heat pumps, for which wind turbines will supply the energy, and district heating will be widely used. Biomass, solar heating, geothermal energy and heat pumps will, together, supply energy for district heating;
- Cars of the future will be fuelled by various combinations of batteries and bio fuels;

Based on the above recommendations, most of five regions of Denmark have begun developing regional climate and energy strategies.

4.1.1.2 Danish Energy Strategy 2050

In February 2011, the Danish Government presented their Energy Strategy 2050. Thereby Denmark was the first country to present a concrete plan for achieving fossil fuel independence by 2050. In accordance with the Commission of Climate Change's recommendations, the future energy supply will mainly be based on electricity produced from renewable energy sources. A number of measures are expected to reduce fossil fuel consumption in the energy sector by 33% in 2020 compared to 2009, and by 100% in 2050 (Danish Ministry of Climate and Energy 2011).

Measures promoting biogas and biomass are:

- improvement of the economic framework for the construction of biogas plants through better subsidiary schemes and improved access to the transmission and distribution

networks;

- The substitution of biomass for coal by providing the opportunity for producers and consumers to agree on an energy price where costs and benefits are reflected
- Introducing free choice of fuels for plants below 20 MW to improve the opportunity for small plants to substitute natural gas with biomass
- Implementation of a 10% biofuel target by 2020

Measures promoting wind power are:

- Making provision for 600 MW offshore wind mill park at Kreigers Flak to be commissioned in 2018-2020
- Conducting a screening of coastal areas to identify areas suitable for additional 400 MW off shore wind
- Promoting the expansion of on shore wind power

Measures promoting intelligent energy systems are:

- An international electricity link will be established in relation to the 600 MW wind mill park at Kreigers Flak
- The introduction of a requirement that all electricity meters replaced after 2015 are replaced with intelligent meters
- Supporting the interaction between fluctuating wind and large heat pumps and CHP in district heating systems

Measures promoting energy efficiency are:

- Increasing the reduction requirements for energy suppliers to 50% from 2013 and to 75% after 2017 up to 2020. Activities will focus on building renovation, conversion of oil and gas based heating to district heating;
- The gradual substitution of oil and gas boilers in buildings. From 2012, installation of oil boilers in new buildings will no longer be permitted, and from 2017 the same is valid for oil boilers in existing buildings;

Measures promoting research, development and demonstration are:

- Supporting the development of minor renewable energy technologies, including solar and wave power. Resources for large ground source heating pump demonstration projects in the district heating sector are set aside, as well as resources for geothermal projects;
- Developing a coherent strategy to ensure, that the national efforts facilitate a transition to fossil fuel independence;

4.1.1.3 Strategic Energy Planning

Municipal strategic energy planning received considerable attention in 2010 in recognition of its importance in relation to the national vision of achieving fossil fuel independence in 2050. The preparation of municipal strategic energy plans is a key recommendation in the Commission of Climate Change's report of September 2010, and it is expected that strategic energy planning will be required or at least strongly recommended by the government before long.

The Local Government Denmark - the interest group and member authority of Danish municipalities – and the Danish Energy Agency have developed a proposition for the approach to strategic energy planning. According to their recommendations, the municipalities must first map the existing energy supply infrastructure, energy demand and resources, including the potentials for renewable energies within their territory. On this basis,

the municipalities should develop a strategic energy plan which is to be updated once every four years. Collaboration between stakeholders is emphasised as a measure to achieve the optimal relationship between energy supply and demand on a national level, and is believed to be necessary to accomplish a transition in the energy system (The Local Government Denmark and the Danish Energy Agency 2010).

4.1.1.4 Strategic Heat Planning

The first national energy strategy was formed in 1976 as a reaction to the 1970s oil crisis and concerns over energy supply security. The first legal act to implement the strategy was the electricity supply act from 1976, which stated that the ministry had the power to approve new power capacity, and the conditions for approval. Since 1976 all new power capacity in Denmark has involved CHP plants situated in the most optimal way with respect to the heat market.

The second important act was the heat supply act from 1979. The objective was to reduce oil consumption and promote the most economically efficient heat supply strategies for each neighbourhood. The act laid down the regulatory framework for a national planning system, for implementing a new natural gas infrastructure and a doubling of the district heating market based on CHP and waste to energy in a cost-effective way. Generally, district heating was specified for districts with sufficient heat density and natural gas for districts with lower heat density. Only very sparsely populated areas are planned for individual heating by oil, biomass or other methods. The law requires co-ordinated planning and collaboration between municipalities, regions, ministries, government and parliament. In addition to their planning role, municipalities formed municipal partnership companies for natural gas, district heating transmission and waste management.

Since the 1990s, Danish heat supply was dominated by a highly efficient district heating system in districts with sufficient heat load, based on CHP and waste to energy from central plants complemented by districts with individual natural gas boilers. All regional energy infrastructure and all heat plans for local distribution networks were implemented. It was now a challenge to ensure maximal connection to the networks and to implement changes to the plans where they could be justified as more cost effective. Consequently, the heat supply act was changed. Heat planning was decentralised to the municipalities. As a result, activities also became more project-oriented and generally received less political priority. The current system meets all the requirements as laid down in the EU directives for Renewable Energy Sources, Energy Efficiency and Buildings with regard to planning of district heating, and to some extent district cooling.

Although municipal heat planning today is still a regulatory requirement, it is not well enforced and is influenced by fragmented initiatives. Not all municipalities meet their obligation and it is a problem for the municipalities that the building code contradicts the heat supply act and the principles in the EU directives. In particular, the EU Energy Efficiency Directive (see Section 3.2.5), which is aimed at ensuring cost-effective development of urban energy infrastructure considering the entire energy chain: from transformation to its distribution and final consumption. In this case, the strict energy requirements of the building codes sometimes forces sub-optimisation and not cost-effective energy supply solutions.

4.1.2 Urban planning schemes

Since the municipal reform in 2007, the municipalities in Denmark have been given full authority over spatial planning within the framework of national regulation. Municipalities are obliged to publish a Municipal Planning Code every four years. The code must take into consideration – but is not bound by – the regional planning strategies developed by the regional authorities. In addition, the Code must comply with national planning directives which are regularly issued by the government.

The Municipal Planning Code should include a strategy for energy and heat supply, waste collection and treatment, including possible waste-to-energy strategies, and undertake a plan of possible wind power production within their physical area. Also, a Local Planning Code is required in advance of any major development project or building construction or demolition project taking place. The Local Planning Code specifies the supply of district energy and stricter regulation on building energy frame.

In addition to the authority devolved in the planning legislation, municipalities are entitled to implement regulations in relation to the sale of own land plots at their discretion (*e.g.* compulsory collection of rain water from roof tops). However, these powers are used only to a limited extent. Altogether, the Danish planning regulation is a key element in the national strategy of promoting energy efficiency and substituting fossil fuels by renewable energy. Further detailed information is supplied in Table A.1 Appendix A.

4.1.3 Scales and geographical boundaries

The levels are defined as follows in the North Harbour context, which is consistent with those used in the other case studies:

- **Neighbourhood** is in the North harbor case defined as Århusgade quarter, where precise data are available on the location of streets and buildings.
- **District is defined as** the whole of the North Harbour, which is covered by a "Structural Plan". Data is available at this scale on neighborhoods, building blocks, and entire city zones.
- **Region** is in this case defined as everything else but the North Harbour. This definition is used since the city might be supplied with wind-power or biomass produced in another part of the country.

4.1.4 Current situation with regard to energy performance

Buildings erected from the late 1970s have been subject to ever stricter energy efficiency codes. Consequently, new buildings use much less energy than the older ones. Much of the old building stock has undergone energy renovation (new windows, improved insulation etc.). Recent studies show that the economically viable potential for further reduction of heat and electricity demand is in the range of 10% (Ramboll 2008). In parallel, still more buildings in Copenhagen have been connected to the district heating network. Heat is supplied by 95% of combined heat and power, and the fuel efficiency of heat is estimated at 200%, assuming that the total CO_2-saving from combined heat and power production is credited to the heat production. Currently more than 98% of all buildings are supplied by district heating.

An increasing share of the CHP plants supplying the district heating runs on biomass (wood and straw). The City is currently working on further conversion of fuel from coal and natural gas to biomass and geothermal energy. The current energy mix of the city and CO_2-emissions are shown in the figures 5, 6 and 7 below. The data is obtained from City of Copenhagen (2011) and Energinet.dk (2011).

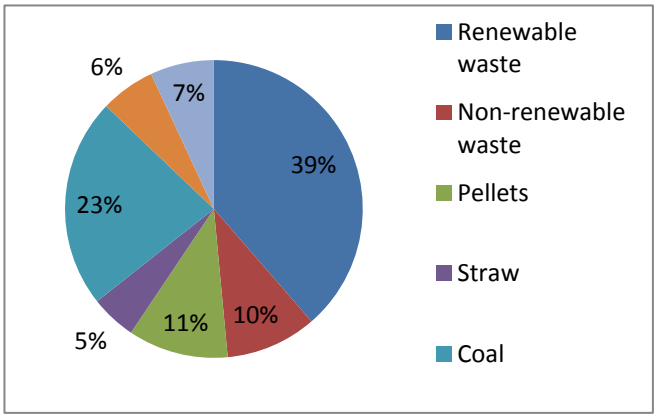

Figure 4. Fuel sources for the district heating network

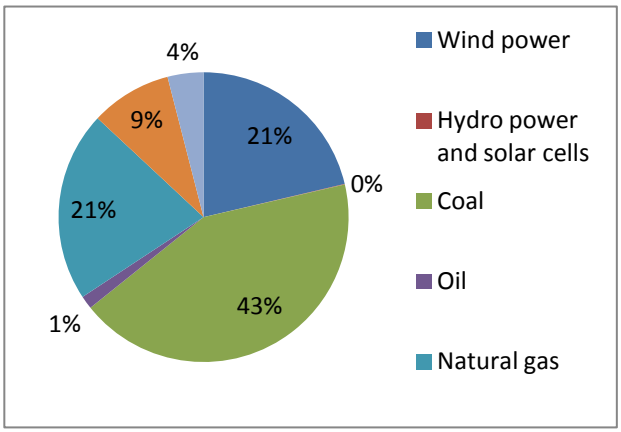

Figure 6. Fuel sources for the electricity from the grid

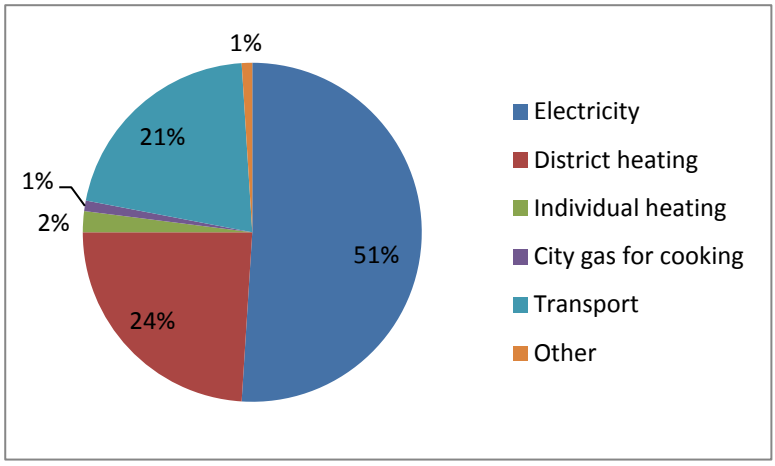

Figure 7. Distribution of total CO_2-emissions (2.541.449 tons CO_2/y)

4.1.5 Description of urban planning project to be evaluated

The North Harbour development project is the largest urban development project in Scandinavia. It is located on the coast of Øresund which is only four kilometres from the centre of Copenhagen (figure 8). Its central position in the Øresunds region will attract many residents, visitors and labour. The City of Copenhagen currently has about 500.000 inhabitants, a number which is expected to increase by 45.000 by 2025. The North Harbour district will be developed over the next 60 to 80 years and is intended to accommodate 40.000 residents as well as providing employment for a further 40.000 people (CPH City and Port

Development 2009).

The North Harbour is intended to be a district of small islets close to the waterfront and a diverse, mixed city with room for everyone. The development project aims to create a CO_2 friendly city, and create a close connection to natural areas without losing out on the quality of life. This vision will become reality by having a sustainable supply of energy to the North Harbour district; by giving high priority to public transport and cycling; and by interweaving natural areas in the city.

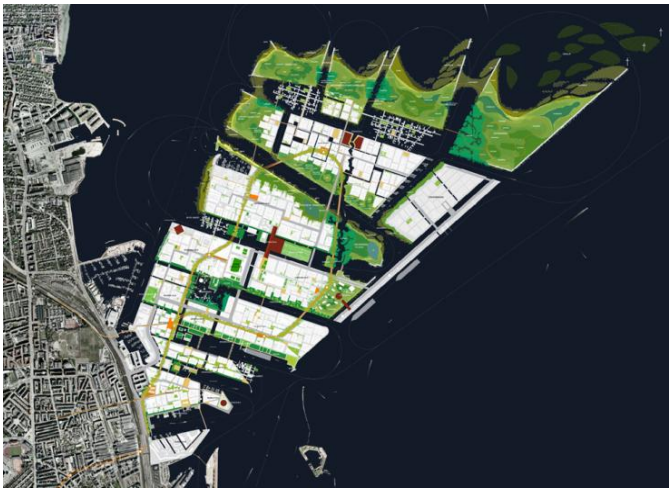

Figure 8. North Harbour project (City of Copenhagen 2011)

The development project is based on six essential themes: Islets and canals; Identity and history; Five-minute city; Blue and green city; CO_2 friendly city; and an Intelligent Grid. All of these provide a robust framework for achieving the vision of creating a sustainable city for the future. This strategy creates cohesion between the various challenges presented to the North Harbour development project and provides the flexibility needed for future sustainable urban development (Copenhagen City and Port Development 2009). The following sections on energy consumption and energy supply alternatives are found in an internal Danish report written by Ramboll for the Copenhagen City and Port Development in 2010 (Ramboll 2010).

4.1.5.1 Energy consumption

Energy use in the North Harbour will be kept at a minimum through energy efficiency measures and through the integration of information technology to control and monitor energy consumption. Buildings and infrastructures will be subject to environmental impact assessment and will be designed to keep resource consumption, waste production and negative environmental impacts to a minimum.

- *Energy efficiency* (*e.g.* use of high energy efficient appliances, lighting systems).
- *Energy use for heating and water* (*e.g.* insulation standards).
- *Energy use for cooling* (on the basis of the calculated variations in the cooling needed there is an annual use of 37 kWh/m^2).
- *Eelectricity use* expected electricity use is 22 kWh/m^2 for residential buildings and 48 kWh/m^2 for office buildings.
- *Monitoring energy use* (*e.g.* on-line access to data concerning the energy use in all buildings and installations, and CO_2 emissions).

4.1.5.2 Energy supply alternatives

The energy supply to the North Harbour is district heating and electricity from Copenhagen

power supply along with gas. The local sustainable energy resources are alternatives to these basic supply lines. All supply of heat and electricity is assessed in a regional context where the production of district heating and electricity is included. District heating and cooling is planned to cover the entire city district area and allows for flexibility in terms of supply technologies. In the short term, well-known and well-tested sustainable energy sources will be used such as solar heating and wind energy. In the long term, the district energy infrastructure and connected heat storage will ensure that the North Harbour will be able to use the future's most appropriate sustainable technologies and sources of energy, for instance sea- and groundwater cooling, solar energy, or geothermal heating extracted from the ground deep below the North Harbour.

4.1.5.2.1 Heat supply:

Central *district heating*, which is distributed to 98% of the residents in Copenhagen, is a relatively sustainable heat supply at a competitive price. The CO_2 from the district heating is approx. 0,1 kg/kWh, and it is expected this will fall even further due to increased efficiency measurements.

Solar heating. The supply of solar heating is limited, without heat storage, to 1/3 of the demand. By establishing heat storage is it possible to increase the share of solar heating up to 100 % of the total heat supply.

	Phase 1	**Fully built**
Built area	470.000 m^2	3.200.000 m^2
Heat demand	16.000 MWh/y	110.000 MWh/y
Solar panel area	45.000 m^2	280.000 m^2
Land area for solar panels	112.500 m^2	700.000 m^2
Storage size	300.000 m3	1.000.000 m3

Table 1. Heat demand, available surface and storage capacity for solar thermal heating

Solar heating in North Harbour is currently not under consideration due to a conflict with surplus of cheap district heating from waste during summertime. Also, the requirement for heat storage makes solar heating more expensive than other heat sources.

Central heat pumps are another measure for district heating, and an alternative to solar heating and storage. The central heat pumps use seawater or the heated water in the groundwater cooling facilities as heat sources and distribute it. The combination of *central heat pumps* and *thermal energy storage* could be even more attractive, with the heat pumps running when the CHPs are standing still, hence extending the capacity of the storage facility.

Geothermal heating is a local energy resource which only affects the environment to a limited extent. The related emissions are caused by the electricity needed for pumping the geothermal water. It is estimated that a fully expanded geothermal facility would be able to deliver five times the heat demanded by the North Harbour development.

Individual heating, such as individual solar heating and individual heat pumps, would also generate the energy needed in the North Harbour but without the benefits of large-scale production

4.1.5.2.2 Electricity supply

The CO_2 emissions from the electricity consumption in the North Harbour will represent 70 % of the total CO_2 emissions from the city district. There are five relevant solutions for the electricity production. These include large-scale windmills, Solar PV panels, micro-windmills, Biogas CHP and Grid power. There is room for four windmills with a combined

capacity of 14,4 MW on the dyke along the new harbour district (1/3 of the North Harbour consumption when completed). There is also a possibility to establish offshore windmills in Øresund. Solar PV panels on buildings have a potential of about 7.000 MWh/y (6 % of the total electricity use). Micro windmills at certain locations, avoiding visual annoyance, offer another possibility. Biogas CHP was rejected in favour of a city waste incineration plant. Consequently, North Harbour will be connected to the city sewage water and waste treatment systems. The final option is Grid power produced at central power plants in Denmark.

4.1.5.2.3 Cooling supply

At North Harbour four different cooling technologies are available, each of which can cover the need for cooling. The technologies are: groundwater cooling, seawater cooling, compression cooling and absorption cooling. The North Harbour has easy access to cold groundwater and the initial survey shows that the exploitation of this cold water for cooling purposes does not seem to obstruct other uses of the water (*e.g.* for drinking. It can be combined with storage for cooling, to increase the capacity in the periods with high cooling demands. The seawater cooling offers another alternative, however it is limited by changes in seawater temperature over the year. In the summer period, it would have to be combined with groundwater cooling or cooling storage. Compression cooling has the potential to create a high demand for electricity which coincides with periods when electricity demand is already high. Absorption cooling is driven by heat instead of electricity. It has lower efficiencies than other forms of cooling, unless the waste heat produced can be used for heating purposes.

4.1.5.2.4 Gas supply

It is still uncertain whether a gas supply infrastructure should be established in the North Harbour development. The installation costs for gas are, in comparison with electricity supply, significantly higher. Furthermore, the potential CO_2 abatement is only 5-10 % when compared to electricity.

4.1.5.2.5 Storage

Thermal energy storage is being considered in the North Harbour area to be connected to the city district heating system. This storage will increase the flexibility of the electricity system. With a large thermal storage, heat supply can be secured even if CHP plants are down due to low electricity prices. Work is on-going to develop the technical concept of heat storage.

4.1.6 Actors and users

A preliminary identification of actors and users is presented in the Table B.1 Appendix B of this document.

4.1.7 Output analysis and data requirements

A series of planning analyses were conducted for North Harbour. At the City level, a range of studies were conducted in relation to the development of the climate action plan of Copenhagen (Copenhagen CO_2 neutral by 2025). In addition, at the Greater Copenhagen level a heat supply study was carried out. A cross-sectoral energy plan for the Regional Capital of Denmark was developed showing how CO_2 reductions could be achieved through energy efficiency measures and renewable energy technologies in a long-term perspective towards 2050.

SEIF would be able to produce the following outcomes for the analysis of the energy and emissions performance of the plan:

- Demand for heating, cooling and electricity
- Climate impacts of energy consumption
- Local energy resources

- Energy savings potential
- Costs of energy savings
- Costs of energy supply, base year and the entire scenario period
- Energy-related CO_2 emissions
- District heating and cooling expansion

Additional information about the expected outcomes, the output level, the data requirements and the related policy frameworks can be found in Table C.1 Appendix C.

4.1.8 Available data sources

The North Harbour case study in Denmark is based on data for projected future energy demand and energy supply in the long term, as nothing is currently built in the case study area. Historical energy data, CO_2 emission factors etc. are available but this type of information is not generally used in simulations of future energy demand and supply. However, some examples of data sources used in the development of scenarios (*e.g.* standard energy consumption of building categories, wind and solar data, emission factors, costs of energy imported and fuels) are described in Section D.1 Appendix D.

4.2 United Kingdom

4.2.1 National and local policy frameworks

This section outlines the national and local policy frameworks for the UK, which covers England, Wales, Scotland and Northern Ireland.

4.2.1.1 UK Climate Change Policy

The 2007 White Paper entitled "Meeting the Energy Challenge" set out the Government's international and domestic energy strategy to address the long-term energy challenges faced by the UK, which is underpinned by 4 key policy goals:

1. To put the UK on a path to cut carbon dioxide emissions by some 60% by about 2050, with real progress by 2020;
2. To maintain reliable energy supplies;
3. To promote competitive markets in the UK and beyond, helping to raise the rate of sustainable economic growth and to improve productivity; and
4. To ensure that every home is adequately and affordable heated.

In 2008 the UK Government established the Climate Change Committee, an independent statutory board under the Climate Change Act (2008), to advise UK and Devolved Administration governments on setting and meeting carbon budgets and preparing for climate change. In 2008 the Committee published its first report, 'Building a low-carbon economy – the UK's contribution to tackling climate change', this report contains advice on the level of the first three carbon budgets and the 2050 target; this advice was accepted by the Government and legislated for by Parliament.

4.2.1.2 UK Energy Strategy 2050

In June 2010, the UK Government produced the '2050 Pathways analysis' which was the first comprehensive, long-term look at the UK's energy supply and demand sectors and greenhouse gas emissions by 2050. This analysis is built around six pathways and, although these pathways differ, there are some common conclusions that help to illustrate some of the energy choices and trade-offs which the UK will have to make over the next 40 years to ensure the UK has low carbon secure energy supplies for the future:

- Ambitious per capita energy demand reduction is needed.
- The greater the constraints on low-carbon energy supply, the greater the reduction in demand will need to be.
- A substantial level of electrification of heating, transport and industry is needed.
- Electricity supply may need to double, and will need to be decarbonised.
- A growing level of variable renewable generation increases the challenge of balancing the electricity grid.
- Sustainable bio-energy is a vital part of the low-carbon energy system, in sectors where electrification is unlikely to be practical, such as in long-haul freight transport and aviation and some industrial high-grade heating processes.

The pathways also show an on-going need for fossil fuels in the UK's energy mix, although their precise long-term role is still under review following a rather diluted commitment to carbon capture and storage research and development.

4.2.1.3 The UK Low Carbon Transition Plan

In 2009, the Government published the UK Low Carbon Transition Plan which detailed the medium term actions to be taken to cut carbon emissions by 34% by 2020, based on 1990 levels (of which 21% has been achieved). As a result, by 2020 it is envisaged that:

- Over 1,2 million people will be employed in green jobs.
- The efficiency of 7 million homes will have been upgraded, with over 1,5 million of them generating renewable energy.
- 40% of electricity will be generated from low carbon sources (renewable energies, nuclear power and clean coal).
- Gas imports will be 50% lower than would otherwise have been the case.
- The average new car will emit 40% less carbon compared to 2009 levels.

4.2.1.4 A framework for action

The UK renewable policy framework is made up of three key components:

Financial support: The UK is establishing a financial framework that provides long-term, comprehensive and targeted support for renewable technologies. Feed-in Tariffs have been developed to incentivise investment in technologies to generate renewable electricity. A Green Investment Bank is being developed to help fund the introduction of renewable technologies.

***Unblocking barriers to delivery*:** The UK Government has taken steps to identify and address those issues that affect timely deployment of established renewable technologies such as: the planning system; supply chains; connection to the grid; and availability and use of sustainable bio-energy. The UK is also taking positive steps to ensure that the electrical network (the grid) is made smarter. A smarter grid will enable the efficient use of networks and greater renewable and distributed energy generation.

Developing emerging technologies: Offshore wind is a key area for development under UK energy policy. The UK is making a commitment to being a world leader in this technology. The new generation of offshore wind generation will play a key role in meeting the UK's 2020 carbon reduction targets. **¡Error! No se encuentra el origen de la referencia.** shows the mix of technologies that may be in use by 2020. This suggests how the UK could see approximately 30% of electricity, 12% heat and 10% transport energy come from renewable sources by 2020 (figure 9).

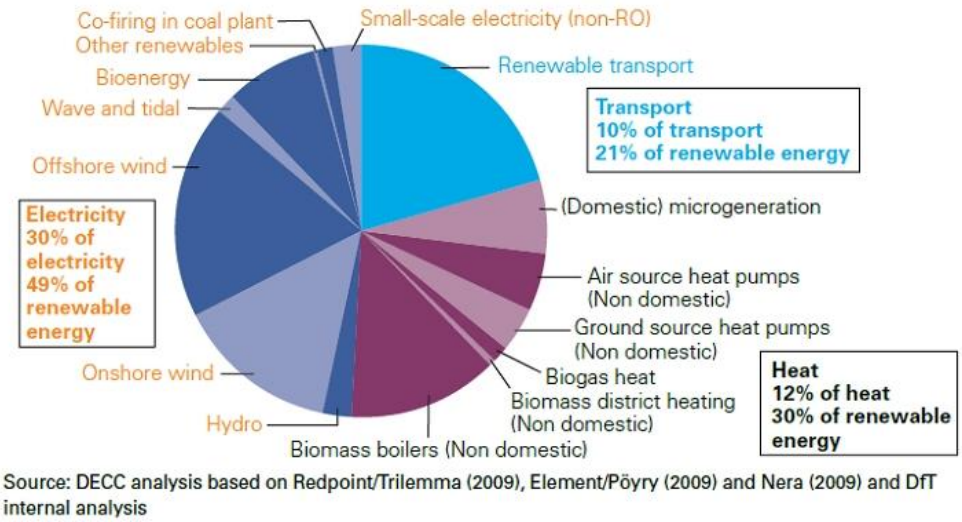

Figure 9. Illustrative mix of technologies in lead scenario 2020 (TWh)

Tables illustrating EU and UK policies on climate change related to this case study are provided in Tables A.2 and A.3 of Appendix A.

4.2.1.5 Local Policy Frameworks

Newcastle upon Tyne, in conjunction with the other eleven local authorities in the North East of England, signed up to the Covenant of Mayors which was officially recognised during the first Covenant of Mayors Ceremony in February 2009 in Brussels, as part of EU Sustainable Energy Week. The North East of England was the first region in the UK and Europe to sign up the Covenant of Mayors. Since then, Newcastle's contribution to tackling climate change has been formalised in a strategy submitted to Europe as part of the City's commitment to the EU Covenant of Mayors on Sustainable Energy. The Strategy (Newcastle City Council 2008b) set out a series of action plans describing how the council plans to deliver carbon emission reductions in Newcastle. Current and future work to tackle the adaptation agenda (preparing for the impacts of climate change) is also outlined.

Key proposals included (Newcastle City Council 2008a):

- To continue to play an integral role in the development of a regional electric vehicle charging infrastructure through the roll-out of electric vehicle charging points
- Energy maps[14] to look at energy consumption across the city with the use of aerial thermal photography to develop city-wide heat-loss profiles
- Development of a carbon route map database and the use of laser technology to identify which roofs in the city would be suitable for photo-voltaic cells
- Development of community energy schemes using centralised gas or biomass combined heat and power units
- Continued development of the Enviro Schools programme working closely with more than 40 schools to encourage behavioural change in young people
- Use of LED sign lanterns and street lights and pilot schemes for solar powered street equipment
- To install high energy efficient traffic signal equipment with controlled illumination levels
- To replace the ten worst-performing heating systems in schools and the delivery of 1.000 domestic installations of photo-voltaic panels
- Continued development of new low carbon industries and establish the Tyne as a world class location for the manufacture and maintenance of wind turbines
- Newcastle/ Gateshead recognised as the UK leader for low carbon skills training

The Strategy and Plan includes the City's Sustainable Energy Action Plan (SEAP), which sets out proposals to deliver the 20% reduction in carbon emissions by 2020 and details the scale of interventions across 29 potential carbon reduction measures. These measures will enable the council to meet its overall targets for carbon reductions in the city.

4.2.2 Urban planning schemes

A Local Planning Authority (LPA), in consultation with its community, is responsible for preparing local planning policies which take into account the unique needs and character of the local community and area, whilst adhering to policy and legislation (including energy) set at a national and regional level. At a local level, Local Planning Authorities (in this case

[14] See http://www.thebiggreenpledge.org.uk/map

Newcastle City Council) are responsible for preparing planning policy in the form of Local Development Frameworks (LDFs), which comprise a suite of documents including:

- Local development scheme;
- An LDS which sets the programme and timetable for document production;
- Development plan documents (DPDs) which are part of the statutory development plan and set out the spatial policies and sites for future development;[15]
- Supplementary planning documents (SPDs) which expand on policies set out in DPDs;
- A statement of community involvement (SCI) which sets out how the community can be involved in the planning process and development plan production;
- An annual monitoring report (AMR) which outlines implementation of policies and monitors progress on the local development scheme;
- For minerals and waste planning, local development frameworks are known as Minerals and Waste Development Frameworks (MWDFs).[16]

In addition, the UK Government (2011) also seeks reforms designed to:

- Devolve greater power and freedoms to councils and neighbourhoods;
- Establish powerful new rights for communities;
- Revolutionise the planning system;
- Give communities more say over housing decisions.

The Local Development Framework (LDF) is the means by which the City Council presents its proposals for the use and development of land; this framework also presents Newcastle City Council's spatial vision until the year 2030. The LDF consists of a number of different documents covering the full suite of planning policies (including energy) that will manage and influence future development in Newcastle. The Local work stream aims to address the impacts of new developments on climate change through the LDF by promoting a range of adaptation methods and identifying achievable policy targets. The LDF will help to address the national targets for reducing greenhouse gas emissions. Work set out in the full document is structured around the following key areas:

- Improving energy efficiency;
- Renewable and low carbon sources of electricity;
- Decentralised energy production;
- Sustainable waste management;
- Water management;
- Green infrastructure and biodiversity.

The LDF provides the policy framework to assist with the delivery of **decentralised energy generation sources**, aimed at procuring energy efficiency, energy savings or reductions in CO_2 emissions. The LDF also aims to promote rather than restrict the use of renewable energy, and develops criteria-based policies to identify potentially suitable areas for renewable and low-carbon energy sources and supporting infrastructure. The LDF will reflect and

[15] The DPDs prepared should include a core strategy document, a site-specific allocation of land document and a proposals map. Separate documents on development control policies setting out criteria to determine planning applications can also be prepared, or these policies can be contained within the core strategy

[16] The minerals and waste development framework forms part of the development plan, which provides the basis for determining planning applications.

enforce the Council's approach to decentralised energy proposals.

4.2.3 Newcastle City Council and Narec Partnership

Narec[17] is providing energy master planning to Newcastle City Council to help implement and agree a sustainable energy action plan and a city-wide climate change strategy, to deliver regeneration and help drive forward the delivery of low carbon and affordable energy schemes in accordance with the climate change and political agenda across the city. Energy master planning for the built environment will help the council to drive forward the delivery of low carbon energy schemes and co-ordinate activity across the council, stakeholders and city, helping them achieve both the national and European carbon reduction targets which form part of the 2010 EU Covenant of Mayors' Agreement, generate additional revenue and increase energy produced from renewable energies.

Narec was appointed by Newcastle City Council to assist them in a technical capacity to develop and deliver a sustainable energy action plan. Narec is responsible for delivering the following:

- Developing an Energy Master Plan for the city to contribute to delivering the Council's aims, objectives and targets, assisting the city's ambitious drive towards sustainability and carbon neutrality;
- Overseeing and managing the transition of plans and strategy through to the delivery of sustainable affordable energy to local communities;
- Leading on the evaluation and implementation of sustainable community energy networks through the selection of Energy Service Companies (ESCos) and other delivery vehicles.

Project completion date is December 2012. During this time the type of carbon reduction projects and renewable energy initiatives and technologies considered to drive forward the City's Low Carbon Energy Scheme will include:

- District/community heating schemes;
- Shared energy schemes;
- Installation of renewable energy generation (in particular photovoltaic panels (PV), solar thermal hot water systems and wind);
- Improved insulation and energy efficiency of all housing stock;
- Skills and training support.

4.2.4 Scales and geographical boundaries

Following NEA and Teesside University's discussions with Newcastle City Council (NCC) we have identified administrative and geographical boundary levels for the UK case study. In line with the requirements of the project, these boundaries are defined at three scales: Neighbourhood, municipal and regional:

- **Neighbourhood.** For the purposes of our study we will refer to a neighbourhood as an area which sits within an electoral ward. In terms of geographic scale a neighbourhood is typically small. Map below illustrates the possible boundary area for the neighbourhood of the Riverside Dene (figure 10).

[17] Narec is a national centre for the UK dedicated to accelerating the deployment and grid integration of renewable energy and low carbon generation see http://www.narec.co.uk/

Figure 10. Neighbourhood scale of the Riverside Dene

- **Municipal.** In the United Kingdom municipal districts are often referred to as wards. A ward in the United Kingdom is an electoral district at sub-national level represented by one or more councillors. Wards are also the primary unit of British Administrative and electoral geography and are typically small in nature. The municipal area we focus on is the electoral ward of Elswick in which Riverside Dene is located. The shaded area on map (figure 11) two identifies the approximate geographical boundaries for the case study at the municipal level.

Figure 11. Municipal scale (ward) of the Riverside Dene

- **Regional (City).** The regional area will comprise the City of Newcastle upon Tyne. An illustration as to how the three boundary areas of neighbourhood, municipal and regional relate to each other is provided in the maps below. The regional boundary map is identified in figure 12.

Figure 12. Regional (City) scale of Riverside Dene

4.2.5 Current situation with regard to energy performance

By signing the EU 'Covenant of Mayors' agreement, Newcastle City Council is committed to delivering a reduction in carbon emissions in excess of 20% by 2020. Newcastle's carbon footprint is approximately (Region) 1,9 million tonnes of CO_2 per year as measured in 2005 by the national indicator NI186 – this is the baseline at city level and is the most recent available estimate.

Calculations based on the regulator for gas and electricity markets' (Ofgem) data modelling, estimates annual baseline CO_2 emissions from the five refurbished tower blocks at about 516.870 kg CO_2 per year. These emissions come from the industrial and commercial sectors (42%), the road transport sector (25%) and the domestic sector (33%).

The above carbon footprint figures for Newcastle upon Tyne are mainly based on CO_2 emissions from gas and electricity use and road transport fuels. They exclude emissions from motorways, shipping and aviation and those covered by the EU Emissions Trading Scheme (although those from power stations are reallocated, based on consumption). Nor do they include emissions that have been released in other countries as result of meeting the demand for energy in the UK. .

As discussed earlier, the Climate Change Act 2008 adopts an 80% reduction target to be reached by 2050 from a 1990 baseline; this includes a 34% reduction by 2020. NCC's strategy is aligned accordingly, meaning a 20% reduction from 2005 to 2020 will deliver Newcastle's part in achieving an emissions level as per the national carbon budget. NCC's commitment under the EU Covenant of Mayors on Sustainable Energy requires the development of a Sustainable Energy Action Plan (SEAP) in line with these targets; this has helped inform the development strategic action plans.

The SEAP carbon reduction scenario includes the scale of interventions across 29 potential measures. By delivering all of these by 2020 they will deliver their overall targets for carbon reductions in the city, as set out above. The calculations from the SEAP are then used to help inform the scale of required delivery programmes within some of the work streams and action plans.

The Domestic Housing work stream aims to address emissions from approximately 122.000 domestic properties in Newcastle, which contribute 34% of the CO_2 generated in the city. Reducing the CO_2 generated in the domestic sector not only makes a substantial contribution towards the overall targets but will also contribute towards improving living standards by helping to reduce fuel poverty and improving the physical condition of the property. Newcastle Warm Zone (NWZ) started in April 2004, this was a city-wide (Region) programme with the primary aim of significantly reducing fuel poverty and improving energy efficiency across all of the city's housing stock by offering free or discounted insulation and heating measures. Up to August 2010, NWZ had:

- Completed over 77.000 home energy efficiency/fuel poverty assessments;
- Delivered almost 45.000 insulation measures and 310.000 low energy light bulbs;
- Secured over £7,5 million in new welfare benefits income;
- Led to a reduction in carbon dioxide emissions of approximately 25.000 tonnes each year (the carbon emissions equivalent of taking around 8.000 cars off the road permanently).

4.2.6 Description of urban planning project to be evaluated

The continued redevelopment of Riverside Dene is the focus of the case study. Work started on the site back in 2009 and has now reached a key stage with five tower blocks completely refurbished and a biomass district heating system installed providing domestic heating and hot

water. Originally the biomass heating system was installed to supply ten refurbished tower blocks, however due to the economic downturn, only five blocks have been refurbished at a cost of approximately £11 million per block.

In October 2010, a comprehensive report outlining the next steps in the regeneration of Riverside Dene to reflect the revised economic climate was considered by the NCC Housing Executive and the following key recommendations were approved:

- Demolition of the remaining un-refurbished tower blocks, Haughton Court, Kings' Meadows, Poplars, Willows and Beeches and disposal of the land for residential and/or mixed use.
- Disposal of the Mary Trevelyan site for mixed use.
- Disposal of Loadman Street for residential use.
- Proceed with the redevelopment of Cruddas Park Shopping Centre
- Extensions to the biomass system to any new developments in Riverside

The demolition of the five remaining tower blocks raises questions over what will be done with the land and what energy implications this may have locally. Clearly there is potential to model various scenarios based on residential and mixed use propositions. Due to the economic downturn plans to redevelop Cruddas Park Shopping Centre have been placed on hold; however there are now proposals to proceed with the refurbishment of the shopping centre subject to adequate funding being identified and secured. Again, there is potential to model various scenarios as to how the redeveloped shopping centre can be heated and supplied with electricity. There is real potential also to expand the existing biomass installation which was originally specified to supply ten tower blocks. Preliminary discussions with NCC have led us to consider the expansion of the current biomass installation to other buildings in the neighbourhood and municipal area.

4.2.6.1 Energy consumption

Energy use across the Riverside Dene development has been kept to a minimum by installing a biomass district heating system providing domestic hot water and heating; high efficiency building materials such as external cladding and high efficiency glazing for all properties within the regenerated area have also been used. LED lighting has also been installed not only to reduce electricity consumption, but to improve the exterior character and identity of the area.

Energy use for heating and water: The annual consumption of the electrically heated properties (before intervention) has been calculated as 2.701.000 kWh. The existing annual energy consumption of the gas heated properties (before intervention) is estimated at 2.148.000 kWh (NEA 2011)

Monitoring energy use: Smart heat meters are to be installed in all of the properties enabling householders to monitor exactly how much energy they are using at any given time.

4.2.6.2 Energy supply alternatives

NCC has initiated a programme to develop new types of energy infrastructure, for example where centralised gas or biomass-fired Combined Heat and Power units would generate electricity for use locally with any excess exported to the grid; at the same time large amounts of hot water are generated that can be shared to different sites for space heating. This type of activity is generally referred to as community energy schemes, decentralised energy or heat networks. In certain circumstances they can also be used for tri-generation where heating, cooling and electricity are generated locally. This type of project is often delivered through Energy Services Companies (ESCos). Newcastle has commissioned technical feasibility work

around these and is in the process of developing methods of delivery through working with partners. In future iterations of the City's climate change programme, this type of project is likely to feature strongly.

There are four relevant sustainable local solutions for the electricity production which will be considered as part of our case study:

***Windmills*:** The suitability of wind power is going to be factored into our case study. Local wind speeds and micro-climates will be taken into consideration when considering this method of electricity generation for the site.

Solar PV Panels: Newcastle City Council has commissioned LiDAR data at 0,5m intervals; this is where an aerial height reading is taken using a laser and then used to calculate the orientation and pitch of roofs across Newcastle The sample image helps identify which buildings have south-facing roofs and can be used to identify by how much roofs vary from the ideal angle for PV of due south, with a pitch of 35-45 degrees. Solar PV clusters will be considered as part of the city's wider plan to generate electricity from renewable sources.

Micro windmills: may be relevant at certain locations, where they will not create visual annoyance and still have good wind conditions. However, the exposure of the Riverside Dene area may lead to micro-climates having a negative effect on the suitability of this measure.

Biomass: As outlined earlier in this document we will be considering the expansion of the existing biomass system at the Riverside Dene site to increase its energy and economic efficiency. At a national level, waste biomass is an under-used resource in the UK which could make a significant contribution to the UK's renewable energy targets and reduce the total amount of waste put into landfill sites in the UK. Figures from 2009 estimate that 6 million tonnes of waste wood and 9 million tonnes of waste food are land filled each year. Strenuous efforts are being made to minimise this waste, but it is clear that a supply of waste food and wood will exist for the foreseeable future. Currently 6 TWh of heat and power is generated from biomass municipal solid waste collected by local authorities, and about 18 TWh from landfill gas. If all the food and wood waste sent to landfill were used for energy it would generate 42 TWh, or approximately 18% of the UK's renewable energy target.

4.2.7 Actors and users

A preliminary identification of actors and users is presented in Table B.1 Appendix B

4.2.8 Output analysis and data requirements

A series of planning analyses have been carried out for the Riverside Dene area, some of which have been accessed whilst others are yet to be provided to the project team. At city level, heat, gas and electricity mapping has been conducted via the 'Newcastle Routemap' project. As part of the work under the Newcastle Carbon Routemap project, NCC has begun to analyse energy consumption across Newcastle at different spatial levels. This has enabled development of a series of maps representing energy consumption across different sectors of Newcastle. The map on the following page presents the average domestic gas consumption per meter at Low Layer Super Output Area in 2008. This holds important information that demonstrates how much gas homes in different parts of the city are consuming.

Other outcomes expected in this case study are related to the following issues:

- Demand for heating, cooling and electricity
- Climate impacts of energy consumption
- Local energy resources
- Energy savings potential
- Costs of energy savings

- Costs of energy supply
- Energy-related CO_2 emissions
- District heating expansion

More detailed information is presented in Table C.1 Appendix C.

4.2.9 Available data sources

The Routemap project has enabled NCC to develop a series of maps that represent energy consumption across different sectors of Newcastle (figures 13, 14, 15 and 16):

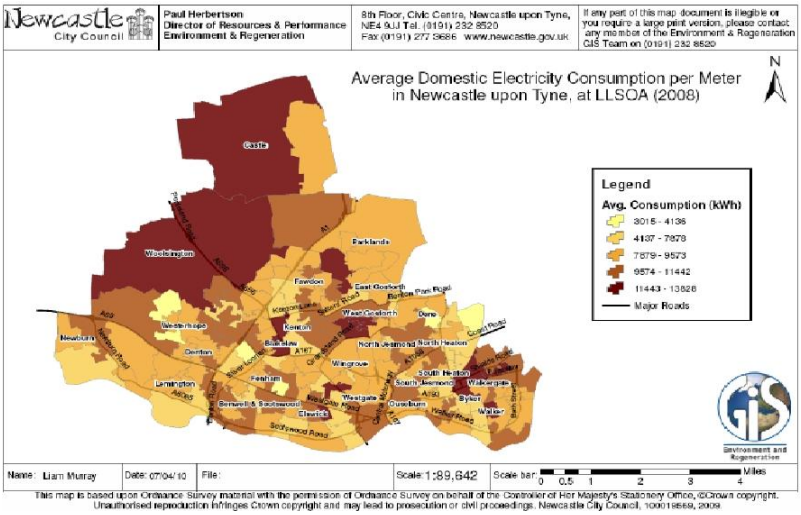

Figure 13. Average Domestic Electricity Consumption per Meter. It does not distinguish between electricity used for space heating (general off-peak) and other purposes. It does however identify certain areas of the city where electricity consumption per household is high. Further work will be undertaken to further analyse off-peak electricity consumption since electric heating is particularly carbon intensive

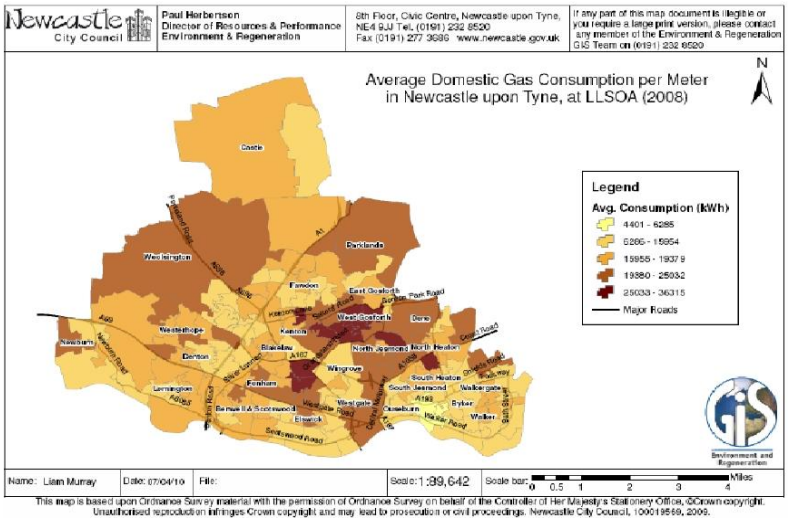

Figure 14. Total Non-Domestic Gas Consumption at Middle Layer Super Output Area. The map shows high gas consumption in the city centre, but also identifies some of the industrial sites in the city and other high gas-consuming areas; in particular, industry in Newburn, Fawdon and Byker stand out as does the Dene area, which could be attributable to the Freeman Hospital. Further work will be undertaken to refine this as it will help target mitigation efforts to support high carbon commercial and industrial activity in Newcastle and at the neighbourhood/ municipal level of Riverside Dene

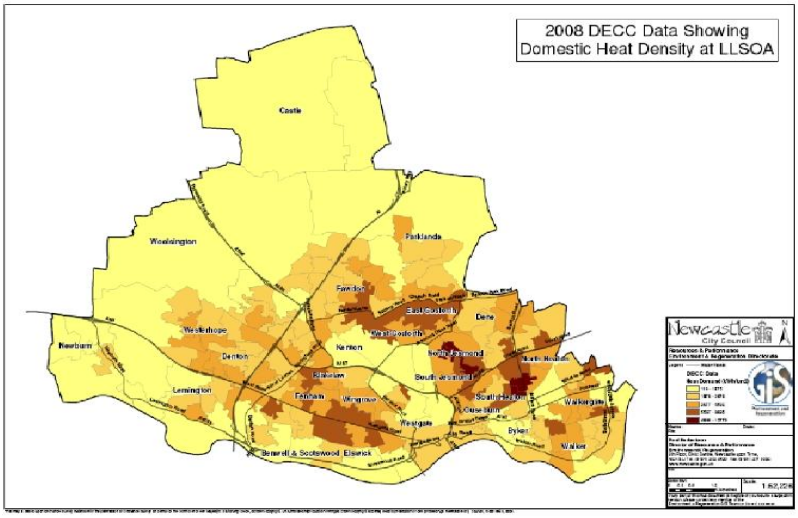

Figure 15. Total Non-Domestic Electricity Consumption at Middle Layer Super Output Area This map simply reflects the high electricity use of the City Centre

Figure 16. Domestic Heat Density at Lower Layer Super Output Area. This map highlights the spatial heat demand from housing. If seeking to develop heat networks that could provide hot water to heat homes, then these areas would be priorities. This is mainly due to the cost of putting heat pipes in the ground; where heat density is high the economics of providing this sort of system are more attractive. This modelling will be applied when consideration is given as to how the biomass heating system at Riverside Denecan can be utilised to its full potential

The description of the corresponding data sources are presented in Section D.2 Appendix D. Most of the data developed in relation to the regeneration of Riverside Dene is based on Ofgem-accredited calculations of energy consumption and CO_2 emissions before and after interventions. Some of the data (*e.g.* energy intensities, activity levels, CO_2 emission factors, energy production prices) is provided in tables compiled in simple excel (.xls) or word files (.doc). For other detailed analysis and studies (*e.g.* solar/ wind or biomass extension simulations) other specialist and expert tools/software programmes may be required to provide input for the energy and CO_2 analysis. However, a complete mapping of data formats and tools has not been carried out at present. This could be carried out in a later phase of the project as input to WP5.

4.3 Spain

4.3.1 National and local policy frameworks

4.3.1.1 National Energy Savings and Efficiency Action Plan 2011-2020

The National Energy Savings and Efficiency Action Plan aims to improve the final energy intensity[18] by an annual decrease of 1,5% between 2010-2020. In this way, the plan would save 20% of primary energy consumption (compared with non-implementation of the plan) (IDAE, 2011a)[19]. However, in absolute terms, this action plan would see primary energy consumption increase by 0,8% between 2010 and 2020.

Two programmes featured within the previous NEEAP 2008-2012 are incorporated within the NEEAP 2011-2020: the Energy Efficiency in Public Buildings Activation Plan and the Plan for the Support of Energy Service Contracts. Both plans develop the market and the Energy Services Enterprises (ESE) that will drive implementation of measures to save energy through increased efficiency in public buildings. These measures are basically of two types: 1) support measures (subsidies) and 2) training and information. . Within the building sector the main effort focuses on the tertiary sector; specifically improving the envelope of buildings and thermal installations, and more efficient lighting systems. The ESE is of fundamental importance to the achievement of energy savings in the housing sector by means of the introduction of district cooling and heating systems that use solar thermal and co-generation technologies. The plan considers the following actions by sector:

Industry (expected 25% of the savings): Technological improvement, favouring the adoption of Available Technological Improvements, the implementation of energy management systems, support for energy audits and public support for investment in industrial assets.

Transport (expected 50% of the savings): Promotion of passenger and freight trains and private car and fleet freight renewal along with the development of urban mobility plans, support for public highways transportation, management of trucking fleets, training in efficient driving of cars, trucks and buses.

Building and facilities: Improvements to the energy efficiency of building envelopes, improvement/promotion of thermal and lighting installations and the improvement of the commercial cold systems. It also considers the construction/renewal of 8,2 million square metres of high energy standards and the construction of nearly zero emissions buildings; and to continue the electric appliances renewal plan.

Public services: The promotion of efficiency in public lighting systems, water treatment plants and energy distribution systems, the training of municipal energy managers and undertaking viability analysis and audits of public lighting systems.

Agriculture and fisheries: The plan considers improvements in irrigation systems, supports a move towards conservation agriculture and the development of energy audits in agricultural systems via capacity building in energy efficiency and the renewal of the machinery.

Energy transformation: Increase the installed capacity of co-generation plants and the renewal of installations more than 15 years old. The plan supports the development of small-scale and non-industrial co-generation systems, energy audits for co-generation and large industrial co-generation plants.

The budget is up to 4,6 million Euros each year for implementation of the plan. The building

[18] Primary energy intensity (toe/€) indicates the amount of primary energy (measured, for instance, in tonnes of oil equivalent – toe) consumed to produce one Euro of GDP.

[19] The plan envisages an annual growth rate of 2,3%, which would imply an increase of primary energy consumption of 20,8% if the plan is not implemented.

and facilities sector will receive most of the resources (about 60% of the budget). The industrial and energy transformation sectors will account for 17,5% and 13% of the budget respectively, while the transport sector will account for about 7% of the budget (which doesn't include investment in infrastructure).

4.3.1.2 Renewable Energy Plan (2012-2020)

The plan promotes improvements in energy savings and energy efficiency and the promotion of renewable energy sources. The share of renewable energy sources would be up to 20,8% of final energy consumption and 11,3% of energy consumed in the transport sector (IDAE 2011b).The plan entails a budget of about 63 million Euros, of which 89% will be used to improve electricity generation. About one third of the costs of the plan correspond to the premiums associated with the special regime of electricity generation.[20] In this way, it is expected to increase the share of renewable electricity by 38%. Onshore wind technology will lead electricity generation from renewable energies with 35 GW of installed capacity, followed by solar thermo-electric and photo-voltaic technologies which will account for 12 GW. The plan also seeks to double the installed capacity of biomass plant and to progressively develop geothermal and wave technologies.

Support frameworks*:* A set of administrative, economic, technical and other instruments will be implemented to promote the use of renewable energy sources, supporting their competitiveness and integration within the energy system. Support frameworks consider economic proposals as well as normative proposals (See Table A.4 Appendix A for more information).

Actions in energy infrastructures: The plan also recommends a set of actions to integrate renewable energy sources within energy infrastructures. It considers actions in electricity infrastructures, natural gas networks and bio/agro-fuels and hydrocarbon logistics (See Table A.5 Appendix A for more information)

4.3.1.3 Technical Code of Edification

As mentioned above, the building and facilities sector will receive most of the economic resources within the National Energy Efficiency Action Plan because this sector has the greatest potential to develop energy saving and efficiency projects. The Code includes a document dealing with occupancy and energy, which establishes the norms and procedures aimed at fulfilling basic requirements of energy savings in new buildings. It also defines the calculation methodology aimed at corroborating the reduction in energy demand (CECU 2008).

The Code defines the basic requirements of energy saving: It limits energy demand, defines the minimum performance of thermal installations, defines the energy efficiency of lighting installations, and the minimum share of solar contribution to hot water and photovoltaic contribution to electricity.

The Code defines the Energy accreditation and qualification framework: the energy consumption necessary to satisfy the energy demand of a building in normal conditions of use and occupation. The Code also defines the Energy Certification process which verifies that the Energy Qualification of the building project is consistent with the constructed building.

Finally, the Code defines the accredited control systems and independent qualified technicians carrying out the qualification and certification tasks.

[20] The current Spanish government has set up a moratorium on the special regime of electricity generation, arguing that the Spanish State has already reached its target for renewable electricity generation.

4.3.2 Urban planning schemes

Urban development is a highly decentralised activity and the Autonomous Communities[21] have a very important role. In this way, the Department of Territory and Sustainability of the Catalonian government approves (or rejects) all territorial ordering plans at the level of the community. To do so, it considers concepts such as mobility (within its administrative territory and beyond), railways, highway traffic, territorial consumption, implementation of major infrastructure projects of supply and distribution, and the current water networks. Also, the Catalan government has control of the development of landscape guidelines and coastal protection law. The legal framework regulating these processes is the Urban Planning Law, which is implemented by a number of different instruments (see below and IDAE 2007).

Territorial plans define the objectives of the different parts of the Catalonian territory. The Territorial plans direct actions towards a defined vision of the territory. In this case, it applies the Territorial Plan of the Central Region

Urban Master Plans according to the Urban Planning Law, establish guidelines to co-ordinate the urban ordering process within a supra-municipal territory. They determine the requirements of sustainable urban development, the mobility of people and freight and public transport, establish measures for undeveloped land, concrete and delimits land reserves for large infrastructure programmes, supra-municipal land and housing policies. In this case, it applies the Urban Master Plan of the Bages.

Catalan municipalities enjoy a high degree of autonomy in the development of the city planning model in terms of the density standards and the amount of protected housing, among other regulations indicated in the above plans. In order to implement this autonomy, municipalities make use of the following planning mechanisms.

General Plans of Urban Ordering (PGOU) that categorise municipal territory into urban land, building land and land protected from urban development. The urban regime of the land depends on land classification or on the zones qualification, and on the inclusion of the land in either polygons of urban development or sectors of derivative planning.

Derivative plans (Partial plans and Special plans) implement the definitions of the general plans in a defined ambit or planning sector classified as urban land or building land. Despite the fact that the General plans and the Derivative plans are written by the municipalities or by the private owner of the land, it is the Department of Territory and Sustainability that ultimately approves the plans.

More detailed information on the urban planning schemes, their description, the relevant actors and the decisions involved can be found in Table A.6 Appendix A.

4.3.3 Scales and geographical boundaries

In Catalonia, different public and private institutions are in charge of applying different urban planning schemes at different geographical scales.

Manresa will be the demonstration site in the Spanish case study, and the CIMNE team will work in close collaboration with the municipality and *Forum* (the municipal-private company in charge of public housing). Therefore, the development of SEMANCO tools will consider the urban planning schemes and the geographical scale in which these institutions operate.

At this point it is worth observing that the Derivative Planning schemes (*Special* and *Partial* urban plans) define/require different degrees of detail when they are implemented at either

[21] Autonomous Community (*comunidad autónoma*) is the first-level political division in Spain established in accordance with the current Spanish Constitution. The second article of the constitution recognises the rights of nationalities and regions to self-government.

building or neighbourhood level. That is, when we develop an urban plan at building level, the information required is much more detailed than when we work at the neighbourhood level.

Therefore, the SEMANCO tools will be required to differentiate between the following levels of analysis.

- ***Buildings***, that is, derivative planning schemes at building level.
- ***Neighbourhoods***, consisting of a group of buildings comprising a block or a neighbourhood (Manresa is formed by 21 neighbourhoods)
- ***The City***, consisting of the main urban area of the municipality. In this case, it comprises the urban area of the city of Manresa. The energy performance at this level can be obtained from the Catalonia Statistics Institute (IDESCAT). It is important to notice that with this information we will be able to cross check the calculations of the performance at both building and neighbourhood levels: the performance at the *municipal* level should be equal to the aggregation of the performance of the neighbourhoods.
- ***Municipality***, consisting of the entire municipality of Manresa: its urban, rural and industrial zones, development of which is regulated by the General Development Plan.

4.3.4 Current situation with regard to energy performance

The city of Manresa has signed the EU agreement "Covenant of Mayors", entailing the submission of its SEAP, where it commits to the reduction of primary energy consumption and CO_2 emissions, and the increase of the share of renewable energy sources in the energy mix. The baseline for the municipality of Manresa is based on its energy and CO_2 emissions in the year 2006. According to data presented by the Municipality of Manresa (n.d.) the energy consumption by type of energy carrier is as follows:

Energy Carrier	***Energy consumption [GWh]***				
	Total	***Household sector***	***Service sector***	***Transport sector***	***Primary and Industrial sectors***
Electricity	**437,3**	118,6	130,8	1,7	186,2
Natural gas	**464,7**	215,6	49,0	0	200,1
Liquefied petroleum gas	**19,3**	11,4	4,4	0,5	3,0
Liquid fuels	**586,3**	8,2	5,4	484,3	88,4

Table 2. Final energy consumption by energy carrier at municipal level in the year 2006 (Municipality of Manresa)

Recently the consumption of electricity has been increasing while the consumption of liquefied petroleum gas (LPG) has decreased. Despite some annual fluctuations, the consumption of liquid fuels shows an increasing trend, and the consumption of natural gas seems stable. With regard to energy generation, hydro-electric power plants in the municipality of Manresa produced about 9,1 and 5,6 [GWh] of electricity in 2006 and 2007 respectively. Local photo-voltaic electricity generation increased from 25 [MWh] in 2006 to about 690 [MWh] in 2007, which contributes to about 2% of the electricity consumption in the municipality. It is estimated that about 1 [MWh/y] of heat will be generated by 1.400 square metres of thermal collectors in the following years.

Regarding greenhouse gas emissions, the same report (Municipality of Manresa 2009) states that the whole municipality emits about 465,5 [kt CO_2 eq/y], which equates to 6,5 [t CO_2 eq/y] per capita. However, these figures should be subject to corroboration since there are some doubts regarding the correct application of calculation protocols. For instance, it is striking that the share of consumption of energy carriers by economic activity is the same as the share of tonnes of CO_2 equivalent emitted by the energy carrier and the economic sector; as if the same emission coefficients have been applied for all the energy carriers. Unfortunately, information is available only at the municipal level. There are no data at the building or at neighbourhood level. However, FORUM and CIMNE, both partners in this project, have implemented energy monitoring projects aimed at collecting data on the energy consumption of several social housing projects and public buildings.

To construct the baseline energy consumption and GHG emissions at building and neighbourhood levels, we will define building typologies for private dwellings, social housing, public facilities and office buildings (see below for more details). This task will be based mainly on real measured data and, if needed, on modelled data. Then, we will aggregate the performance of building typologies according to their spatial distribution (*scaling-up*) in order to obtain the performance of the neighbourhood or group of buildings.

4.3.5 Description of urban planning projects to be evaluated

The aim of the case study is to validate the application of SEMANCO methodologies and tools (SEIF), at least, at building and neighbourhood levels. Also, the case study considers the use of SEIF to assess the energy performance and CO_2 emissions of projected urban plans at city level.

Validation of SEIF: In a first phase, we will validate SEIF in the Casc Antic district (the old town of the city). There, an integrated urban planning refurbishment of buildings and the urban environment has been taking place over the last ten years, and will continue in future years. As previously mentioned, we can get real energy and socio-economic information before and after implementation of some actions. In this phase we will work at building and neighbourhood levels. At the **building level**, we will analyse the performance of six blocks of public housing apartments (220 dwellings; most of them are of new construction) and two refurbished public buildings. Currently, we have information about the technical specifications of the buildings and their monthly energy consumption. Also, we have detailed monitored energy data for 108 dwellings, and there is the possibility of accessing historical monthly energy consumption for 60 dwellings constructed in the 1970s without energy efficiency measures. Regarding public buildings and facilities, we have the monthly energy consumption for 157 public buildings from a remote energy information system (SIE), and for around of 35 of these buildings we also have energy audit information. All of this information will support the comparative analysis of the buildings' performance to validate the analysis.

This target group of new and refurbished buildings will be compared with other buildings without energy saving measures, to validate different scenarios of energy reduction with SEMANCO tools (figure 17).

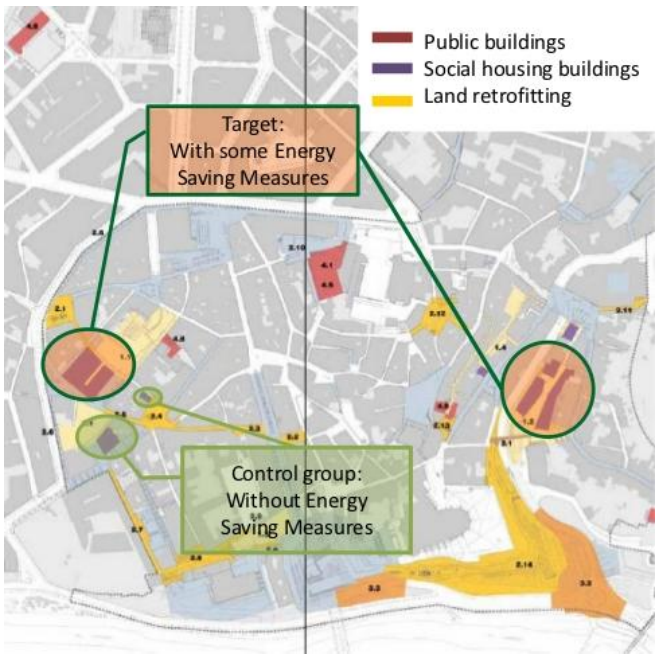

Figure 17. Comparison of target and control buildings

Other important data sources are: the open source GIS provided by the municipality; the general energy information for the city provided by the calculations and database of the SEAP; and supra-municipal socio-economic data provided by the Catalonian statistic agency (IDESCAT).

We also envisage that we will capture technical information about the electric equipment and appliances used in different public housing apartments and public buildings. This phase of the data collection will also include a description of HVAC installations, DHW installations, lighting installations and local energy sources (micro- CHP, RES.).

The analysis at the **neighbourhood level** requires the definition of some building typologies based on the structural characteristics of the buildings, their use (residential, public, offices) and the socio-economic characteristics of their occupants. These building typologies will be used to up-scale energy consumption analysis from the building scale to the neighbourhood scale. The description of building typologies will consider the energy carriers used (and their amount) and final use within the building.

The description of the building typologies includes exterior structure, use, shape, orientation, age/building regulation, socio-economic status of occupants, consumption of energy carriers and final energy use.

Starting from the analysis of these building typologies, we will define some density classes and distributions at the neighbourhood level: streets and orientation, general districts classification (nodal - high density, mixed use, pedestrian-oriented, compact - moderate density, transit-oriented, sprawl - low density, single use auto-oriented), definition of use sectors (industrial, services, public…), identification of the existing energy supply infrastructure (district heating, electricity grid..) and analysis of the socio-economic environment (mainly in the housing sector).

Then, we will be able to aggregate the performance at building level to obtain the performance at neighbourhood level.

Assessment of projected urban plan: In a second phase, we will consider the application of SEIF to assess the scenarios of energy consumption and CO_2 emissions at building, neighbourhood and city (*i.e.* urban area) levels. Scenarios will be developed that fit the future

general urban plan of the city. To do so, an extrapolation of assumptions and methodologies from the old town results will be used.

The energy calculations will be based on building typologies and energy simulations of the different sectors and different energy sources available.

We will analyse some of the following potential future scenarios, according to the requirements of the actors and users involved:

- Implementation of thermal and photo-voltaic solar energy panels in new and existing buildings.
- Simulation of the configuration of gas, water and electricity networks to assess their capacity to be integrated with local energy generation power plants.
- Simulation of the potential reduction in energy consumption that can be achieved by upgrading building fabric (internal and external insulation) windows (glass and frames) and natural or passive shading elements.
- Implementation of small wind turbines
- Replacement of decentralised boilers with district heating systems
- Simulation of highly efficient air conditioning systems and geothermal systems for office buildings and high consumers
- Simulation of occupant behaviour change scenarios that could be achieved by energy awareness programs to support lifestyle changes that reduce energy use.

4.3.6 Actors and users

A preliminary list of potential actors and users is presented in Table B.1 Appendix B.

4.3.7 Output analysis and data requirements

SEIF should support analysis of the energy and emissions performance of the plan and may include

- Demand for final energy use;
- Demand for different energy carriers;
- CO_2 emissions and reduction compared to baseline;
- Share of energy carriers from renewable energy sources;
- Primary energy consumption and reduction with respect to baseline;
- Share of local energy carriers;
- Share of local energy carriers from renewable energy sources;
- Cost of supply of final energy uses;
- Cost of implementation;
- Social inclusion and cohesion.

More detailed information about the expected outcomes, the output level, the data requirements and the related policy frameworks can be found in Table C.1 Appendix C. The Appendix also includes a set of potential indicators for each of the expected outcomes listed above (Table C.2 Appendix C).

4.3.8 Available Data Sources

The data sources in the Manresa case study are available at the building, neighbourhood and municipal levels. Detailed information on the characteristics of these data sources is presented in Section D.3 Appendix D.

4.3.8.1 Building

- Energy consumption of public buildings (billing, monitoring)
- Energy consumption of public social housing (hourly energy consumption)
- Technical data of refurbished buildings (geometrical and technical information)
- Energy legal requirements of new buildings
- Technical data of new buildings (geometrical and technical information)

4.3.8.2 Neighbourhood level

- Urban plans for refurbished neighbourhood
- Socio-economic data for new urban areas (predicted for families and activities)

4.3.8.3 City level

- Annual energy consumption of the municipality
- Census information (population, demographics)
- Geographic data (geographical and geometrical data for Manresa in GIS)
- Land registry information
- Urban planning information

5 CONCLUSIONS

5.1 Contribution to overall picture

The main objective of task 2.1 is to focus the scope of the research on the case studies by means of identifying practical strategies to reduce CO_2 emissions via urban planning linked to real world scenarios.

As such, it sets the basis for the future development of SEMANCO. In this sense, the report provides the information required to reduce the generality of the problem addressed; by identifying the measures and strategies currently being implemented to reduce CO_2 emissions in urban planning. It also provides the initial requirements for the development of the semantic-based tools needed to support these planning activities

The report includes information about the following issues:

- Main international policy frameworks determining urban planning and the strategies for reducing CO_2 emissions;
- National and local policy frameworks and urban planning schemes;
- A preliminary identification of relevant actors involved in the urban planning processes and the potential users of SEIF that have different interests and expectations regarding the outcomes of urban planning development;
- A preliminary definition of expected outcomes of the analytical tools developed that determine the scope and the domain of SEIF;
- Data requirements and available data and data sources;
- A baseline of energy consumption and CO_2 emissions at municipal level, which can be extended to lower levels of analysis

The report shows how urban developments are framed by different local urban planning schemes across the three case studies, but also illustrates how they are guided by national and international policies dealing with the issue of energy consumption and CO_2 emissions. However we can find different settings across case studies which, together with the different conceptualisations of the space, make the definition of the scales of analysis a complex task.

5.2 Impact on other WPs and Tasks

Overall, Task 2.1 provides valuable information to continue with the planned activities in the other WPs. It provides preliminary information on the potential actors and users to be incorporated in WP6 for the development of scenarios. It also defines a preliminary list of expected outcomes, which frames the development of strategies and indicators for data modelling and data analysis (T2.2). It identifies the available data sources and the required data to be processed in WP3 and determines the preliminary requirements of tools and methods for energy and CO_2 emissions analysis (WP5) which will be integrated with the SEIF (WP4).

5.3 Contribution to demonstration

As mentioned in the DoW, the framework and tools developed by SEMANCO will be used within each case study to demonstrate quantifiable and significant reductions in energy consumption and CO_2 emissions, achieved by means of the application of the ICTs developed by SEMANCO.

Within the demonstration and validation process, the Semantic Energy Information

Framework (SEIF) is expected to support the following tasks:

Tasks in the demonstration phases	Contribution of Deliverable 2.1
The automated identification and classification of buildings for energy analysis within a geographic area	Not applicable
The identification and visualisation of 'energy use hot spots' to support the effective targeting of urban energy efficiency and renewable energy interventions	Not applicable
Assessment of the potential of different technical and social interventions and strategies to reduce CO_2 emissions at different geographic scales;	Preliminary description of interventions and strategies to reduce CO_2 emissions considered within each case study Recognition of the complexities entailed by the definition of the analytical scales and preliminary definition of micro, meso and macro scales
Optimisation or trade-offs between conflicting social, economic, political and environmental constraints within planning and design practice to support stakeholder decision making;	Description of the international, national and local policy frameworks and local urban planning schemes, which frame (or constrain) the urban planning practices in each case study.
Extracting guidelines to apply to other areas and projects, providing planning authorities (local, national and European) with appropriate indicators for monitoring and reporting that can be used to establish future planning strategies;	Not applicable
Predicting future demand following demographic and economic changes by identifying patterns of growth and sustainable urban developments which reduce energy consumption	Preliminary definition of the baseline of energy consumption and CO_2 emissions in each demonstration scenario. The performance of the final demonstration scenarios – developed with the support of the methods and tools developed in SEMANCO – will be compared against those baselines.

In summary, WP8 will demonstrate and validate the value of the decision support tools in terms of their cost effectiveness and ability to support informed planning decisions that reduce CO_2 emissions from the built environment, which will be conducted within the **scenarios** and **end-users** identified in the case studies.

5.4 Other conclusions and lessons learned

The report states that to define a set of scale categories appropriate to all circumstances is not feasible. The scales of analysis are context-dependent and should be defined according to the problem at hand and to the purpose of the analysis. However, it is also true that a multiple scale assessment of the energy performance of urban development is needed. For this reason, the report defines three general categories of analytical scales: the **micro**, **meso** and **macro** scales.

The fact that there are certain properties of the system that are not possessed by any of the individual parts making up the whole, and *vice versa*, entails important consequences in the processes of perceiving and representing the system. This issue should be seriously considered in the following tasks that will define the methods and tools to be used for the calculation of energy performance and CO_2 emissions (and other socio-economic and

environmental indicators) of the demonstration scenarios, because they should produce coherent outcomes across scales. Moreover, we should research and define methodologies that are capable of verifying the required coherence across scales.

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7 GLOSSARY

Energy carrier

Correspond to the various forms of energy inputs required by the various sectors of society to perform their functions. Examples of energy carriers include liquid fuel in a furnace, gasoline in a pump, electricity in a factory or a house and hydrogen in a tank of a car (Giampietro and Mayumi 2009, Giampietro and Sorman 2011). They are also referred as *secondary energy*, which are all sources of energy that result from transformation of primary energy sources.

Energy end-uses

In the context of urban planning, energy end-uses refer to useful tasks and works performed in a built environment that convert energy carriers into applied power. Examples of energy end-uses are lighting, heating, cooling sanitary hot water and electric appliances.

Primary energy sources

Correspond to those sources that only involve extraction and capture. That is, the term refers to the energy forms required by the energy sector to generate the supply of energy carriers used by society. Examples of primary energy sources are below-ground fossil energy reserves (coal, gas, and oil), blowing wind, falling water, solar radiation and biomass. It is extremely important to differentiate Primary Energy Sources from Energy Carriers. The concepts refer to energy forms of different quality and used at different hierarchical levels of the society. They cannot be aggregated since 1 MJ of an energy carrier is not the same than 1 MJ of primary energy source (Giampietro and Mayumi 2009, Giampietro and Sorman 2011).

Greenhouse gas.

It refers to a gas in the atmosphere that absorbs and emits radiation within the thermal infrared range. The primary greenhouse gases in the Earth's atmosphere are water vapour, carbon dioxide, methane, nitrous oxide, and ozone.

For more information on energy-related terms, see:

http://ourenergyfutures.org/page-cid-7.html

8. APPENDICES

APPENDIX A. National Legislation and Urban Planning

7.1.1 A.1 North Harbour

Urban planning scheme	*Description*	*Relevant actors*	*Decisions made*	*Related national/local policy framework*
Municipal Planning Code	• Municipalities are obliged to perform a Municipal Planning Code every four years. • Energy supply. The Municipal Planning Code should include a socio-economic efficient strategy for supply of heat to each of the districts of the municipality. • Municipal codes should include a strategy for waste collection and treatment, including possible waste-to-energy strategies. • Municipalities are also obliged to undertake a plan of possible wind power production within their physical area.	• The municipality • Investors /developers • Contractors • Energy suppliers • Waste management companies • Wind power companies	Choose the most socio-economic efficient strategy for energy supply and waste treatment	• Danish planning regulation • Regional planning strategies • National planning directives • Heat Supply Act • Strategy for waste collection and treatment • Plan of possible wind power production
Local Planning Code	• A Local Planning Code is required before any major development project or building construction or demolition project takes place. • The Local Planning Code specifies in detail which land plots will be supplied with district energy. The Code may also specify stricter regulation on building energy frame than the minimum	• The municipality • Investors • Contractors • Energy suppliers	The code may specify stricter regulation on building energy frame than the national minimum requirements	• National building code • Danish planning regulation

	requirements in the national building code.			

Table 7.1.1 Urban planning schemes relevant to the North Harbour case study

7.1.2 A.2 Newcastle Upon Tyne

Legislation	**Contents**
Sustainable Energy Act 2003	Led to development of 2004 UK Energy Efficiency Action Plan with an aim to save 4,2 Mt CO_2/y by 2010.
Housing Act 2004	Introduced the HIPs (Home Information Packs) and Energy Performance Certificates. Requires the general level of energy efficiency of residential accommodation in England to be increased by at least 20% compared to general level of such energy efficiency in 2000.
Energy Act 2004	Makes provision for the development, regulation and encouragement of the use of renewable energy sources.
Climate Change Act 2008	Makes a key provision for a carbon budgeting system that caps emissions over five-year periods 2008-2012, 2013-2017 and 2018-2022. Local councils as a part of National Indicator (NI) 186 were required to report annually on the percentage of reduction in CO2 emissions per capita from their area including both public and private housing. This indicator has since been revoked by the Coalition Government to reduce the burden of local authority monitoring duties.
Heat & Energy Saving Strategy	Sets out the objective that emissions from existing homes should be approaching zero by 2050

Table 7.2.1 UK legislation on energy

Urban planning scheme	***Description***	***Relevant actors/users***	***Decisions made***
The UK Low Carbon Transition Plan	The UK Low Carbon Transition Plan details the medium-term actions to be taken to cut carbon emissions by 34% by 2020, based on 1990 levels. It also envisages that over 1.2 million people will be employed in green jobs, the efficiency of seven million homes will have been upgraded, 40% of electricity will be generated from low carbon sources, gas imports will be 50% lower than would otherwise have been the case and the average new car will emit 40% less carbon compared to 2009 levels.	Central Government Local Government Local Authorities / Town Planners Energy companies Distribution network operators (Electricity) Waste management companies	UK energy strategy 2050 Heat & Energy Saving Strategy - Sets out the objective that emissions from existing homes should be approaching zero by 2050
Local Policy Frameworks which include the Covenant of Mayors	The Sustainable Energy Action Plan, (SEAP) sets out proposals to deliver a 20% reduction in carbon emissions by 2020 and details the scale of required interventions across 29 potential carbon reduction measures across the City of Newcastle.	Local Government Local Authorities / Town Planners Energy companies Private sector contractors Waste management companies	Practical measures and installations required to deliver a 20% reduction in carbon emissions by 2020.

A Local Planning Authority (LPA)	LPA responsible for the creation of Local Development Frameworks (LDF) which include the following: Local development scheme; An LDS which sets the programme and timetable for document production; Development plan documents (DPDs) which are part of the statutory development plan and set out the spatial policies and sites for future development;[22] Supplementary planning documents (SPDs) which expand on policies set out in DPDs; A statement of community involvement (SCI) which sets out how the community can be involved in the planning process and development plan production; An annual monitoring report (AMR) which outlines implementation of policies and monitors progress on the local development scheme; For minerals and waste planning, local development frameworks are known as Minerals and Waste Development Frameworks (MWDFs)	Local Authority Urban Planners Developers Private sector contractors Waste management companies Not for profit agencies (Warm Zones / NEA)	The LDP provides the policy framework to assist with the delivery of decentralised energy generation sources, aimed at procuring energy efficiency, energy savings or reductions in CO_2 emissions Localism Bill in 2011

[22] The DPDs prepared should include a core strategy document, a site-specific allocation of land document and a proposals map. Separate documents on development control policies setting out criteria to determine planning applications can also be prepared, or these policies can be contained within the core strategy

Newcastle City Council and Narec	Newcastle City Council and Narec have set up a partnership in which Narec will assist the city council in a technical capacity to develop and deliver a sustainable energy action plan. Narec is responsible for developing an Energy Master Plan towards sustainability and carbon neutrality, managing the transition of plans and strategy, and leading on the evaluation and implementation of sustainable community energy networks through the selection of Energy Service Companies (ESCOs) and other delivery vehicles.	Newcastle City Council (LA) Narec Warm Zones Newcastle Local contractors and private sector supply chain. Northern Power Grid (Electrical Distribution network operator) Energy companies	Energy master planning for the built environment will help the council to drive forward the delivery of low carbon energy schemes and co-ordinate activity across the council, stakeholders and city, helping them achieve both the national and European carbon reduction targets which form part of the 2010 EU Covenant of Mayors' Agreement, generate additional revenue and increase energy produced from renewable energies.

Table 7.2.2 Urban planning schemes relevant to the Newcastle case study

7.1.3 A.3 Manresa

Table 7.3.1 Spanish legislation on energy (Support frameworks and proposals of the Spanish energy-related legal framework)

Support frameworks	Economic proposals	Normative proposals
• Special regime of electricity production from renewable energy sources. It considers premium payments in order to assure reasonable returns on investment. The definition of the premiums will depend on specific technical and economic aspects of each technology, the installed capacity of the plants, the number of working hours of the plant and the year of starting operations. • System of incentives for renewable heating (ICAREN). Direct support system to Energy Services Enterprises (ESEs) supplying thermal energy. • Net Energy Balance. The plan will promote the development of distributed electricity generation by means of photo-voltaic and small-wind technologies, which will contribute to the development of a self-supply framework. In order to support self-supply, the plan considers the net balancing mechanism. It entails an energy balance compensation system, in which self-supply consumers can “store” electricity surpluses for subsequent recovery. This system will be part of a global demand management system encompassing the progressive implementation of smart grids, the implementation of distributed generation systems and a gradual increase in self-supply.	• Public support to project investment and actions. For instance, public support for research and technological development; to geothermal studies; to innovation and demonstration of thermal and bio-fuels applications; to demonstration of electricity generation technologies; applications of isolated electric networks andnet balance, agreements with the autonomous communities; and to generation of industrial biogas. • Public funding of research and technological development demonstration projects; projects in commercial phase facing obstacles that hinder its development, funding and promotion of ESEs, funding of distributed electricity generation for self-supply.	• These proposals include development of energy-demand management systems and smart grids; simplification of administrative procedures for renewable energy installations; adaptation of the special regime to different sectors; specific treatment of network connections of small capacity installations; reduction of administrative barriers to research and development projects on renewable electricity generation; and modification of the Technical Code of Edification. • Within the field of cooling and heating, it considers the development of a special legal framework supporting thermal energy provision produced from renewable energy sources by Energy Services Enterprises (ESE). • The plan also considers the development of bio/agro-fuels to power the transport sector by means of reducing the hydrocarbons taxes to zero and the obligation to use bio/agro-fuels in the transport sector. Also, the plan proposes to design norms and certifications at European and Spanish levels in order to characterise fuel mixes up to 10% of bio/agro-diesel (B10), as well as the realisation of technical studies with the aim of fostering the development of B10 transport by pipelines. • The plans also considers development of a normative framework in order to allow use of bio-methane in the natural gas networks, with special attention to the distribution networks

Table 7.3.2. Spanish legislation on energy (Actions of energy infrastructures considered in the Spanish energy-related legal framework)

	Actions in energy infrastructures
Electricity infrastructures	Regarding electric infrastructures, we can identify three groups of proposals. Firstly, adaptation of the Special Regime Control Centre to the envisaged renewable energy mix and the modification of the Operation Procedures in order to obtain similar performances and services from the renewable energy technologies. Second, we find the proposals related to demand management, such as the development of smart grids, the modulation of industrial consumption and the implementation of smart meters. Third, it considers the development of electricity storage systems, such as pumped storage hydro-electricity. This is the most mature storage method to compensate for variations in non-manageable renewable energy sources and to store any surplus. Renewable energy sources are of fundamental importance within the building sector where there are ambitions to achieve the nearly zero energy building concept. The main action within this sector is the modification of the Technical Edification Code. This normative and ruling momentum includes a solar contribution to hot sanitary water, the definition of a minimum limit of thermal energy produced from renewable sources in new and renewed buildings and the establishment of a normative framework prioritising heating and cooling systems over other supply technologies.
Natural gas networks	To advance normative proposals facilitating the injection of biogas to the natural gas networks, assuring system security and allowing non-discriminatory access to the network.
Bio/agro-fuels and hydrocarbon logistics	Besides the definition of a European and Spanish norm regulating B10 mixes, the plan considers to start the studies aimed at assessing the consequences of transporting biofuels (B10) by hydrocarbon pipelines

Table 7.3.3 Urban planning schemes relevant to the Manresa case study

Urban planning scheme	***Description***	***Relevant actors/users***	***Decisions made***
Territorial Plans	It is the instrument that defines the general and main objectives of the different parts of the Catalonian territory. It directs action towards a defined vision of the territory. In the case of, it applies the Territorial Plan of the Central Region.	Planning Department, Government of Catalonia	The department is in charge of writing the plan. It defines the general vision for all Catalonia land, concerning issues such as large settlements, main roads, hydrological networks and all kind of traffic in and out of the territory. Also, it provides guidelines on large-scale production of energy (whatever the type) and its distribution.
		Municipal department of urban planning. Head of department, GIS technicians, architects, drafters.	The municipality has the right to comment on plans and these views can be incorporated within the plan

Urban planning scheme	*Description*	*Relevant actors/users*	*Decisions made*
		Municipal department of environment	
Urban Master Plans	According to the Urban Planning Law, the Urban Master Plans establish the guidelines to co-ordinate the urban ordering process within a supra-municipal territory. It determines the requirements of a sustainable urban development, the mobility of people and freight and public transport, establishes measures of undeveloped land, concretes and delimits land reserves for big infrastructures, and programmes supra-municipal land and housing policies in conjunction with affected municipalities. In this case, it applies the Urban Master Plan of the Bages. Catalan municipalities enjoy a high degree of autonomy in establishing their preferred planning model including on density standards and the amount of protected housing, among other regulations indicated in the above-mentioned plans. In order to implement this autonomy, municipalities make use of the following planning mechanisms.	Planning Department, Government of Catalonia	The department is in charge of writing the master plans. It has to realise, in a supra-municipal territory, the general vision described on the territorial plans in order to match the general vision with the real territory (topography, owners, municipalities affected, etc.). It has to provide the necessary directives for implementation of the General Plans (See below). In the framework of the SEMANCO project, it is important because it defines the reserves of space for the location of the elements concerning energy described earlier.
		Municipality department of urban planning. Head of department, GIS technicians, architects, drafters,	The municipality has the right to comment on the plans and its opinions can be included in the plan. It can also participate in defending city interests where these may be in conflict with those of other municipalities. *e.g.* “Is the city interested in having within its territory a solar plant able to supply beyond its limits? “
		Municipal department of environment	
		Municipal department of facilities. Public lighting	
		Municipal department of energy and renewable energy	
		Energy and water supply companies. Electricity, gas, water.	Companies act as observers. Despite this, they can become an important actor, especially if they manage the budget for the implementation of generation plants or distribution networks.
		Energy services companies	Currently, these companies will act as observers in relation to energy issues within the Urban Master Plan.

Urban planning scheme	***Description***	***Relevant actors/users***	***Decisions made***
General Plans of Urban Ordering (PGOU)	These plans classify the land of the municipal territory: urban land, building land and land protected from urban development. The urban regime of the land depends on land classification or on the zones' qualification, and on the inclusion of the land in either polygons of urban development or sectors of derivative planning.	Municipal department of urban planning. Head of department, GIS technicians, architects, drafters,	The urban planning department is in charge of urban development. Sometimes the work is externalised, but the municipality itself leads the writing of the plans. Many factors and actors are taken into account. That's why many departments are involved in making decisions. Decisions become more concrete at this scale. In general terms, all decisions within the limits of the municipality are taken within the framework of the general plan *e.g.* "The general plan will oblige buildings of new development to generate 60% of the energy consumed"
		Municipal department of environment	Many departments are involved in taking decisions, all of which are submitted to the Urban Planning Department
		Municipal department of energy and renewable energy	
		Municipal department of facilities. Public lighting	
		Municipal company of social housing. Principal and Technicians	
		Energy and water supply companies. Electricity, gas, water, …	In order to prepare the supply of primary energy, these companies are important actors to be considered. Their opinion/experience in the territory could influence the making of decisions concerning energy issues.
		Energy services companies	The private sector and all their actors/users have significant interest in the results of the General Plan. Nevertheless they are not able to directly participate in decision making. They can however present well-argued individual requirements to be included in the plan.
		Private architect/technician	
		Regular citizens	
		Private housing promoter	
		Private equipment promoter	

Urban planning scheme	***Description***	***Relevant actors/users***	***Decisions made***
Derivative Plans (Partial and Special Plans)	These plans implement the definitions of the General plans in a defined ambit or planning sector classified as urban land or building land. Despite the fact that the General plans and the Derivative plans are written by the municipalities or by the private owner of the land, it is the Department of Territory and Sustainability that ultimately approves the plans	Private housing promoter	These plans can be developed by private actors such as the council's own planning department. It is the final document prior to the writing of building and construction projects, and it contains the latest decisions related to buildings, neighbourhoods and urban environments *e.g.* "The general Plan obliges compliance with the requirement that 60% of energy be generated on site. In order to do so, we will specify in the special plan district heating with geothermal energy beneath the surface facilities, and require all buildings to be raised to high levels of energy efficiency (A)".
		Private equipment promoter	
		Private architect/technician	
		Compensation board: Assembly of urban promoters and owners of the site in which works would take place (partial and special plans)	
		Municipal company of housing. Principal and technicians	
		Energy and water supply companies. Electricity, gas, water, …	At these scales, supply companies or energy services companies will be consulted in order to evaluate the real viability of the proposals described.
		Energy services companies	
		Municipal department of urban planning. Head of department, GIS technicians, architects, drafters,	The municipality could act as promoter of the document in cases of public interest. In those cases, the decisions are the same than the ones made by private actors. Otherwise, the municipality has to review the derivative plans redacted in order to determine whether the document is complying with the conditions established in the General Plan *e.g.* "The proposal to implement district heating and buildings with high levels of efficiency is sufficient to achieve the 60% target. Does this proposal fit or contradict the others parameters of the General Plan?"
		Municipal department of facilities. Public lighting	
		Municipal department of energy and renewable energy	
		Municipal department of environment	

APPENDIX B. Preliminary identification of relevant actors

Table 7.3. Actors and users

Actor/User	Case study	Description	Scale of action	Policy/planning scheme	Role
Harbour Development	North Harbour	Interested in: Functionalities of impact assessment of buildings, Functionality of early assessment of costs of alternative energy supply options	Responsible for preparation of land use regulation, and land preparation within the new city district		Key stakeholder Land owner and developer
City Authority/ Municipality	North Harbour Newcastle Manresa	The relationship between consumption and occupancy allows a degree of control far more direct than the current one. Also, it allows improved knowledge of the actual occupancy of dwellings. This is an important issue in considering urban development.	Responsible for the approval of master plans and land use codes within the municipality	Manresa Technical Code of Edification Sustainable Energy Action Plan of Manresa Newcastle Strategic Housing Planning and Transportation. Environment and regeneration directorate	Local authority/ potential user of the tool Defines certain minimum requirements Overseeing implementation of neighbourhood, municipal and regional (city-wide) strategic housing plans
Copenhagen Energy	North Harbour	Supplier of water, district heating and gas	Action on a local scale, within the new city district		Supplier/potential user of the tool Assessment of: Cost-benefit of varying urban layout, varying energy intensities, and varying implementation schedules
The Capital Region of Denmark	North Harbour	Responsible for regional planning	Action on a regional scale, within the capital region of Denmark		Regional authority Responsible for: climate and energy plans for the region, transport infrastructure, hospitals etc.

Actor/User	Case study	Description	Scale of action	Policy/planning scheme	Role
Consultants	North Harbour New Castle Manresa	Consultant companies	Use of the tool can be on neighbourhood, district and regional scale.		Potential user of the tool It is believed to be relevant for consultants to use the tool, provided that there is a market for the results provided by the tool
Your Homes Newcastle	Newcastle	Social Housing Provider.	Neighbourhood/ Municipal/ Region	Energy Services Manager	Provision of social housing to the decent homes standard set out by Government dept – Communities and Local Government
Wates Construction	Newcastle	Private Sector Contractor.	Neighbourhood/ Municipal/ Region	Project manager(s)/building surveyor(s)/ construction engineer(s)	Develop and carry out construction works on the site.
Vital Energy Ltd	Newcastle	Renewable energy managing agent.	Neighbourhood	Project manager(s)/Maintenance manager(s)/ Engineer(s)	Install and maintain biomass boiler on site.
Private housing promoter	North Harbour Newcastle Manresa	May have an interest in the energy performance of buildings to be promoted or the area where the building is constructed, as a preliminary step for energy certification established in state law.	Building	Manresa Technical Code of Edification Urban master plans Derivative plans	Energy efficiency of a building or group of buildings, simulated with SEMANCO
Private equipment promoter	North Harbour Newcastle Manresa	May have an interest in the energy performance of buildings to be promoted or the area where the building is constructed, as a preliminary step for energy certification established in state law.	Building	Manresa Technical Code of Edification Urban master plans Derivative plans	Energy efficiency of a building or group of buildings, simulated with SEIF

Actor/User	Case study	Description	Scale of action	Policy/planning scheme	Role
President of neighbouring communities	North Harbour Newcastle Manresa	They may have an interest in understanding the behaviour of their building, and related to its environment, to evaluate possible interventions (envelope, installing renewable energy …)	Building	Manresa Technical Code of Edification Derivative plans	Environmental behaviour of the building.
Private architect/technician	North Harbour Newcastle Manresa	Professionals working in building, urbanisation or urban planning projects could have access to the application to support decision making.	Building, neighbourhood	Manresa Technical Code of Edification Derivative plans	Environmental behaviour of a building or a group of buildings, modelled with SEIF
Regular citizens	North Harbour Newcastle Manresa	Ordinary citizens can access specific data for different reasons and at different levels. From simple curiosity (general information) or to be informed about the energy performance of their neighbourhood, their building or even their home.	All	Manresa Technical Code of Edification Territorial plans Urban master plans General plan of urban ordering Derivative plans	Access to data generated with SEIF, related to general behaviour of the entire city, neighbourhood or a building.
Principals of public/private facilities (libraries, primary care centres, schools, fitness centres...)	North Harbour Newcastle Manresa	The directors may want to know the energy performance of the equipment they manage. For instance, to compare it with other facilities and to fit their budgets and decide on general policies of action.	Building, neighbourhood	Manresa Technical Code of Edification Derivative plans	General information about consumption of its building and comparison with other similar facilities. Economic impact of this energy consumption.

Actor/User	Case study	Description	Scale of action	Policy/planning scheme	Role
Tenants of public housing	North Harbour Newcastle Manresa	As users of public resource, they are encouraged to improve their performance on energy consumption. It's possible they want to know how they are doing, or how the building performs in relation to other buildings.	Building	Manresa Technical Code of Edification Urban master plans Derivative plans	General information on energy consumed in own buildings and in comparison with other buildings.
Social welfare department	North Harbour Newcastle Manresa	As energy bills are increasingly important, the social welfare services can use the data extracted by the application for generating policies for awareness on consumption, directed geographically to areas of high consumption..	Neighbourhood, city		General map of the city with consumption distributed by areas to identify “hot spots”
Compensation board: Assembly of urban promoters and owners of the site in which works would take place (partial and special plans)	Manresa	As owners, the compensation board may want to know the energy performance of new urban development within partial and special plans.	Neighbourhood	Manresa Technical Code of Edification Derivative plans	Energy efficiency of a building or group of buildings, simulated with SEIF

Actor/User	Case study	Description	Scale of action	Policy/planning scheme	Role
Energy and water supply companies. Electricity, gas, water, …	North Harbour Newcastle Manresa	Utility supply companies are best placed of all to benefit from the project. The distribution of actual consumption in the region, overlaid with grid electricity, gas and water can greatly help to improve estimates and ensure correct dimensions in the construction and renovation of infrastructure.	City, municipality, region	Manresa Technical Code of Edification Territorial plans Urban master plans Derivative plans	General map of the city with consumption distributed by areas to identify “hot spots”.
Energy services companies	North Harbour Newcastle Manresa	The proliferation of companies that offer energy services makes them ideally placed to study the results of the application to quantify, budget and offer their services to most extreme "hot spots" within the city, either at administrative or individual property owner level.	Neighbourhood, city	Manresa Technical Code of Edification Urban master plans Derivative plans	Data on the energy performance of the wider city, possibility to zoom in to neighbourhoods.
Municipality department of urban planning. Head of department, GIS technicians, architects, drafters,	North Harbour Newcastle Manresa	As users, workers of the department of urban planning of the municipality can use the tool for modelling different options on urban development.	City, municipality, region	Manresa Technical Code of Edification Urban master plans General plan of urban ordering Derivative plans	Maps of the energy performance of existing urban fabric. Full access to modelling tool in order to work on development of new areas.

Actor/User	Case study	Description	Scale of action	Policy/planning scheme	Role
Municipal department of environment	North Harbour Newcastle Manresa	The department of environment can use the tool to study and disseminate information on the environmental performance of the city or the suburbs and to develop policies to raise awareness among the general public.	City, municipality, region	Manresa Technical Code of Edification Urban master plans General plan of urban ordering Derivative plans	Submission of data in different scale and form, for use in the creation of various reports and studies.
Municipal company of housing. Principal	Manresa	Principal of housing company can study regular standards on buildings to decide about the policy or new levels to achieve in new projects.	Building, neighbourhood	Manresa Technical Code of Edification Urban master plans General plan of urban ordering Derivative plans.	Access to energy data consumption in residential buildings enabling study and comparison with own buildings
Municipal company of housing. Technicians	Manresa	Technicians could simulate with the tool the best environmental options among the projects competing to develop new buildings or complex of buildings.	Building, neighbourhood	Manresa Technical Code of Edification Urban master plans General plan of urban ordering Derivative plans	Full access to modelling tool in order to achieve better standards on residential building constructions.
Municipal department of facilities. Public lighting	North Harbour Newcastle Manresa	Tool could be able to evaluate the energy consumption of the public lighting as well, providing important information about energy consumed and lighting distributed in the city.	City	Manresa Technical Code of Edification Territorial plans Urban master plans General plan of urban ordering Derivative plans	Ask for maps of the energy performance of the city road network. Also access to modelling tool for projecting new urbanisation or changes to existing net.

Actor/User	Case study	Description	Scale of action	Policy/planning scheme	Role
Municipal department of facilities. Maintenance technicians	North Harbour Newcastle Manresa	Technicians in charge of public building maintenance can use the application to identify the best and worst performing buildings with a view to improving all.	Building	Manresa Technical Code of Edification Derivative plans	Obtain general information about consumption of all facilities they are in charge of. Detailed information on each building.
Municipal department of energy and renewable energy	North Harbour Newcastle Manresa	Tool could be effective in simulating renewable energy projects to be implemented at a large scale: district heating, photo-voltaic field on roofs or solar power plants, for example. Always taking decisions in close collaboration with urban planners.	Neighbourhood, city	Manresa Technical Code of Edification Master plans General plan of urban ordering Derivative plans	User asking for maps of the energy performance of existing urban fabric. Overlay with available areas for implementation of facilities. Access to modelling tool for experiment with possibilities of implementation and generation.

APPENDIX C. Expected outcomes and data requirements

Table 7.4. Expected outcomes and data requirements

Expected output	***Output level***	***Data requirements***	***Related national/local policy framework***
Demand for final energy uses	Sanitary hot water, lightning, heating, electric appliances and cooling. Mainly at building level. Some of the final energy use also applies to district heating systems (if implemented).	• Detailed parameters for characterisation of buildings: envelope, insulation, windows, appliances, energy generation systems, user behaviour (building level) (to model energy performance or to define typologies based on measured energy performance) • Standard energy consumption for certain building categories (kWh/m^2) of cooling, heating and electricity • Average wind speed (building level) • Orientation and shading (neighbourhood and building level) • Distribution of final energy use per typology of building • Inventory of buildings at different levels (amount, typologies and distribution) • Measured energy consumption of individual buildings or districts • Key energy consumption data for specific commercial and industrial sectors (kWh/m^2)	North Harbour • CPH City and Port Development requirements • CPH Climate Action Plan • National building regulations • National energy efficiency targets and obligations Manresa • National Energy Efficiency Action Plan 2011-2020 • Technical Code of Edification • Sustainable Energy Action Plan of Manresa

Expected output	***Output level***	***Data requirements***	***Related national/local policy framework***
Demand for different energy carriers	Consumption of electricity, liquid fuels (diesel & gasoline), natural gas and LPG. At building, neighbourhood and city levels.	• Monthly energy bills (public buildings, social housing) • Yearly consumption of energy carriers at different levels (building, neighbourhood, city, municipality) Expected consumption of energy carriers for different building typologies • Inventory of buildings in the neighbourhood (number, typologies and distribution) • Expected consumption of energy carriers for different commercial and industrial areas, facilities and other non-residential buildings • Consumption of energy carriers at municipal level • Socio-demographic data (demographic structure, income, land value...)	North Harbour • CPH City and Port Development requirements • CPH Climate Action Plan • National building regulations • National energy efficiency targets and obligations Manresa • National Energy Efficiency Action Plan 2011-2020 • Technical Code of Edification • Sustainable Energy Action Plan of Manresa
Energy saving potential	Savings potential by type of building (kWh/m^2), of electricity, cooling, heating, for different types of buildings and different levels of ambition	• matrix of "before"; "after"; and associated energy savings (kWh/m^2)	North Harbour • CPH City and Port Development requirements • CPH Climate Action Plan • National building regulations • National energy efficiency targets and obligations Manresa • National Energy Efficiency Action Plan 2011-2020 • Technical Code of Edification • Sustainable Energy Action Plan of Manresa

Expected output	*Output level*	*Data requirements*	*Related national/local policy framework*
CO_2 emissions and reduction compared to baseline	CO_2 emissions and savings at building, neighbourhood and city levels	• Mix of energy carriers • Primary energy mix (to produce the mix of energy carriers) • Technical co-efficient of CO_2 emissions for each primary energy source • Demand for different energy carriers at neighbourhood level • Primary energy mix (to produce the mix of energy carriers) • Technical coefficient of CO_2 emissions for each primary energy source • Demand for different energy carriers at municipal level • Primary energy mix (to produce the mix of energy carriers) • Technical coefficient of CO_2 emissions for each primary energy source	North Harbour • CPH City and Port Development requirements • CPH Climate Action Plan • National building regulations • National energy efficiency targets and obligations Manresa • National Energy Efficiency Action Plan 2011-2020 • Technical Code of Edification • Sustainable Energy Action Plan of Manresa
Share of energy carriers from renewable energy sources	Consumption of electricity from small hydro-electric, wind farms and pv. At building, neighbourhood and city levels.	• Data records of wind from meteorological station and urban estimations • Data records of solar radiation (hourly) • Estimation of horizontal and inclined available surface • Urban configuration and free surface for biomass co-generation heating plants (CHP) • Details of capacity of the electricity network (transformation stations, type of electric cables, etc.)	North Harbour • CPH City and Port Development requirements • CPH Climate Action Plan • National building regulations • National energy efficiency targets and obligations Manresa • Renewable Energy Plan (2012-2020) • Sustainable Energy Action Plan of Manresa

Expected output	***Output level***	***Data requirements***	***Related national/local policy framework***
Primary energy consumption and reduction with respect to baseline	Consumption of primary energy sources at city level.	• Primary energy mix for electricity generation at local and national level • Oil requirements for diesel, gasoline and LPG production • Data records of solar radiation	North Harbour • CPH City and Port Development requirements • CPH Climate Action Plan • National building regulations • National energy efficiency targets and obligations Manresa • National Energy Efficiency Action Plan 2011-2020 • Sustainable Energy Action Plan of Manresa
Share of local energy carriers	Share of electricity produced locally at building and neighbourhood levels. Peak and annual output potential of solar heating and solar pv Wind energy potential	• Electricity generation at building, neighbourhood and municipal level • Hourly sunlight exposure data • Electronic map of the area, including building orientation • LiDAR mapping and imagery.	North Harbour • CPH City and Port Development requirements • CPH Climate Action Plan • National building regulations • National energy efficiency targets and obligations Manresa • National Energy Efficiency Action Plan 2011-2020 • Technical Code of Edification • Sustainable Energy Action Plan of Manresa
Share of local energy carriers from renewable energy sources	Share of renewable energy carriers produced locally with respect to total amount of energy carriers locally produced, at building and neighbourhood levels.	• Electricity generation from RES and building, neighbourhood and municipal level	North Harbour • CPH City and Port Development requirements • CPH Climate Action Plan • National building regulations • National energy efficiency targets and obligations Manresa • Sustainable Energy Action Plan of Manresa • Renewable Energy Plan (2012-2020)
District heating and cooling expansion	Draft design of the district heating/cooling network	• Matrix of cost elements, such as costs of 1m pipe to expand biomass system. • Electronic maps of the area, including information about soil contamination, existing underground infrastructure, heat intensities at local level (kWh/m^2	North Harbour • CPH City and Port Development requirements • CPH Climate Action Plan • National building regulations

Expected output	*Output level*	*Data requirements*	*Related national/local policy framework*
		of ground area)	• National energy efficiency targets and obligations
Cost of supply of final energy use	Cost of supply of final energy use mainly at building level. Some of these costs also apply to neighbourhood/district level (*e.g.* district heating systems if implemented).	• Cost of imported energy carriers • Cost of operation and maintenance of local energy supply system • Cost of locally produced energy	North Harbour • CPH City and Port Development requirements • CPH Climate Action Plan • National building regulations • National energy efficiency targets and obligations Manresa • N/a
Cost of implementation	At building, neighbourhood or city level depending on the scale of action.	• Cost of works (labour, materials...)	North Harbour • CPH City and Port Development requirements • CPH Climate Action Plan • National building regulations • National energy efficiency targets and obligations Manresa • N/a
Social inclusion and cohesion	Distribution of income and access to energy services at neighbourhood and city/municipal levels	• Socio-economic status of potential occupants of new buildings • Socio-economic data at neighbourhood and municipal levels. • Building typologies at neighbourhood and municipal levels.	North Harbour • CPH City and Port Development requirements • CPH Climate Action Plan • National building regulations • National energy efficiency targets and obligations Manresa • N/a

Table 7.5. Expected outcomes and preliminary selection of indicators

Expected output	**Potential indicators**
Demand for final energy uses	Final energy use per year: - Sanitary hot water (kWh/y) - Lightning (kWh/y) - Heating (kWh/y) - Electric appliances (kWh/y) - Cooling (kWh/y) per square metre: - Sanitary hot water (kWh/y·m^2) - Lighting (kWh/y·m^2) - Heating (kWh/y·m^2) - Electric appliances (kWh/y·m^2) - Cooling (kWh/y·m^2)
Demand for different energy carriers	Consumption of energy carriers: - Electricity consumption [kWh/year] - Diesel consumption [kWh/year] - Gasoline consumption [kWh/year] - Natural gas consumption [kWh/year] - LPG consumption [kWh/year] per square metre. - Electricity consumption [kWh/y·m^2] - Diesel consumption [kWh/y·m^2] - Gasoline consumption [kWh/y·m^2] - Natural gas consumption [kWh/y·m^2] - LPG consumption [kWh/y·m^2]
CO_2 emissions and reduction compared to baseline	- CO_2 emissions [t/y] - CO_2 savings [% with respect to baseline] - CO_2 emissions [t/y·m^2] - CO_2 savings [% with respect to baseline]
Share of energy carriers from renewable energy sources	- Share of electricity from RES [%] - Share of heat from RES [%]
Primary energy consumption and reduction with respect to baseline	- Electricity from hydro-power [kWh/y] - Electricity from wind power [kWh/y] - Electricity from PV [kWh/y] - Electricity from nuclear [kWh/y] - Natural gas consumption [kWh/y] - Oil consumption [kWh/y] - Coal consumption [kWh/y] - Thermal solar [kWh/y]
Share of local energy carriers	- Share of electricity produced locally [%]
Share of local energy carriers from renewable energy sources	- Share of local energy carriers from RES [%]
Cost of supply of final energy use	- Cost of supply by final energy use [€/y]
Cost of implementation	- Implementation costs [€]

Expected output	**Potential indicators**
Social inclusion and cohesion	⅄ Distribution of income at neighbourhood level ⅄ Distribution of income at municipal level. ⅄ Percentage of population with access to energy services (final energy use) [%]

APPENDIX D. Available data sources

7.1.4 D.1 North Harbour case studies

Field name	**Description**
Name	Gross floor area
Long name	Gross floor area for the built environment (1,000 m^2)
Description	Data describing the gross floor area for the built environment within categories *e.g.* households, offices, public buildings in a baseline scenario.
Author	CPH City & Port Development
Domain	City development
Format	Excel
Access type	Export from the LEAP model in Excel
Date range	From 2012 to 2030

Field name	***Description***
Name	Standard energy demand
Long name	Energy use for heating, cooling, hot water, and electricity (kWh/m^2)
Description	Energy use data divided between households and offices
Author	Expert calculations based on current and future energy requirements in building codes
Domain	Specific energy consumption
Format	Excel
Access type	Export from the LEAP model in Excel
Date range	From 2012 to 2020

Field name	***Description***
Name	The exogenous capacity of wind
Long name	The exogenous capacity of wind (MW)
Description	The data show the exogenous capacity of wind, and how it evolves over time
Author	Expert calculations based on hourly wind energy production data from existing off-shore wind farm outside the Harbour of Copenhagen called "Middelgrunden"
Domain	Energy production
Format	Excel
Access type	Export from the LEAP model in Excel
Date range	From 2012 to 2030

Field name	***Description***
Name	The exogenous capacity of solar cells
Long name	The exogenous capacity of solar cells (kW)
Description	The data show the exogenous capacity of solar cells, and how it evolves over time
Author	Expert calculations based on assumptions of total available roof area in North Harbour and efficiency of solar panels
Domain	Energy production

Format	Excel
Access type	Export from the LEAP model in Excel
Date range	From 2012 to 2030

Field name	***Description***
Name	Emission factors
Long name	CO_2 emissions from energy supply (Kg CO_2/kWh)
Description	The data show the emission factors for the following energy supply alternatives: central district heating, land-based solar heating, geothermal heating, and the electricity grid
Author	Local Energy Utility (Copenhagen Energy) and National Energy Transmission Company (Energinet.dk)
Domain	Energy supply
Format	Excel
Access type	Export from the LEAP model in Excel
Date range	From 2012 to 2030

Field name	***Description***
Name	Energy prices
Long name	Energy prices (EUR/kWh)
Description	Energy prices for different energy supply forms
Author	Danish Energy Authority
Domain	Energy prices
Format	Excel
Access type	Export from the LEAP model in Excel
Date range	From 2012 to 2030

7.1.5 D.2 Newcastle case study

Field name	***Description***
Name	Average Domestic Electricity Consumption per Meter
Long name	Average Domestic Electricity Consumption per Meter Newcastle upon Tyne Lower Layer Super Output Area 2008
Description	Data describing average electricity consumption across the city. Municipal and neighbourhood area.
Author	Newcastle Carbon Routemap Project (Paul Herbertson)
Domain	Energy consumption
Format	Excel
Access type	Export from the Routemap project to Excel
Date range	2008

Field name	***Description***
Name	Average Domestic Gas Consumption per Meter
Long name	Average Domestic Gas consumption per Meter Newcastle upon Tyne Lower Layer Super Output Area 2008
Description	Data describing average gas consumption across the city. Municipal and neighbourhood area.
Author	Newcastle Carbon Routemap Project (Paul Herbertson)
Domain	Energy consumption
Format	Excel
Access type	Export from the Routemap project to Excel
Date range	2008

Field name	***Description***
Name	Average Domestic Heat Density
Long name	Average Domestic Heat consumption Newcastle upon Tyne Lower Layer Super Output Area 2008
Description	Data describing average heat consumption across the city. Municipal and neighbourhood area.
Author	Newcastle Carbon Routemap Project (Paul Herbertson)
Domain	Energy consumption
Format	Excel
Access type	Export from the Routemap project to Excel
Date range	2008

Field name	***Description***
Name	LiDAR Thermal Imaging of Newcastle
Long name	LiDAR mapping illustrating thermal imaging data
Description	Aerial thermal imaging for the City of Newcastle upon Tyne
Author	Resources and Performance - (Environment and Regeneration Directorate)

	Newcastle City Council
Domain	Energy consumption
Format	Excel
Access type	Export from LiDAR modelling to Excel
Date range	2008

7.1.6 D.3 Manresa case study

a) Building level

Field name	***Description***
Name	Public building consumption
Long name	Monthly billed consumption of public buildings,
Description	Real and billed monthly data of public buildings, from an Internet Energy Information System (SIE)
Author	Municipality of Manresa
Domain	Energy consumption
Format	SQL database, and geographical data
Access type	Web services
Date range	From 2006 to 2011

Field name	***Description***
Name	Energy consumption of public housing
Long name	Hourly energy consumption of public housing,
Description	Hourly data of energy consumption, weather data, Tindoor, and Temperature and flow data of HVAC system, for around 75 public dwellings
Author	Municipality of Manresa-CIMNE
Domain	Energy consumption
Format	SQL database
Access type	Web services
Date range	From 2010 to 2013

Field name	***Description***
Name	Technical data of refurbished buildings
Long name	Geometrical and technical data of refurbished public housing buildings in the cases studies
Description	All technical and plot data from technical projects of around 5 blocks of public housing rebuilt or refurbished in the case study area (*casc antic*)
Author	Municipality of Manresa-FORUM
Domain	Technical data buildings
Format	CAD, and .doc, .xls files
Access type	By e-mail
Date range	From 2007 to 2012

Field name	***Description***
Name	Energy legal requirements of new buildings
Long name	Ratio (kWh/m^2, t CO_2/m^2) and technical specifications for new buildings
Description	Ratio (kWh/m^2, t CO_2/m^2) and technical specifications for new housing buildings according to the Energy Code in Spain (simplified)
Author	Municipality of Manresa-ICAEN
Domain	Energy legal requirements of new buildings
Format	.xls
Access type	By e-mail

Date range	From 2013 to 2014

Field name	***Description***
Name	Technical data of new buildings
Long name	Geometrical and technical data of new buildings in the case studies
Description	Geometrical and technical data of some new private housing, public housing and public buildings in the case studies
Author	Municipality of Manresa-FORUM
Domain	Technical data buildings
Format	CAD, and .doc, .xls files, and .shp files
Access type	By e-mail
Date range	From 2013 to 2014

b) Neighbourhood level

Field name	***Description***
Name	Urban Plans data for refurbished neighbourhood
Long name	Technical and geometrical data of special, partial and integrated urban plans in the case study area
Description	Geodata base, areas of activity, soil classification, height orientation and other technical data, at neighbourhood level for all the special, partial and /or integrated urban plans of the Casc Antic area items listed
Author	Municipality of Manresa-FORUM
Domain	Urban Planning data
Format	shape files (.shp) and databes files (.sql)
Access type	by e-mail, may be web services
Date range	From 2008 to 2011

Field name	***Description***
Name	Socio-economic data for new urban areas
Long name	Socio-economic predicted data from families and from activities
Description	Rent income, typologies of families and activities predicted in new case areas
Author	Municipality of Manresa-Forum
Domain	Urban Planning data
Format	shape files (.shp) and database files (.sql)
Access type	by e-mail, perhaps web services
Date range	From 2013 to 2014

c) City level

Field name	***Description***
Name	Annual Energy Consumption
Long name	Total Municipal Energy Consumption per Year
Description	Annual Consumption of Electricity, Gas, and Liquid Fuels for Residential, Industrial and Service Sectors
Author	ICAEN, Ministry of Energy and Industry of Catalonia
Domain	Energy
Format	Excel files (.xls)
Access type	e-mail from ICAEN with excel sheet
Date range	From 2008 to 2011

Field name	***Description***
Name	Population census information
Long name	Data of existing census information
Description	Population census where information such as name, gender, birth date, movement, direction, education, nationality, is available for each house or minimum plot level. This information can be linked using the address with the graphics layer and the layer of cadastral plots.
Author	Municipality of Manresa
Domain	Demographic information
Format	shape files (.shp) and database files (.sql)
Access type	
Date range	From 2008 to 2011

Field name	***Description***
Name	Geographic data
Long name	Geographical and geometrical data of Manresa in GIS
Description	Geodata base and meta data of elements, surfaces, plots, data from pavement, and geometrical data, hydrographic and terrain data, trees and other elements.
Author	Municipality of Manresa
Domain	Geographical data
Format	shape files (.shp) and database files (.sql)
Access type	
Date range	From 2008 to 2011

Field name	***Description***
Name	Land registry data
Long name	Data of land registry of Plots and subplots
Description	Land registry alpha-numeric database where all information is for each plot (surface) (property, owners, uses, values, ...) and graphic information composed of : Islands (Polygons, and limits centroids) Plots (Polygons, and limits centroids) Subplots (Polygons, and limits centroides)
Author	Municipality of Manresa

Domain	Land Registry Data
Format	shape files (.shp) and database files (.sql)
Access type	
Date range	From 2008 to 2011

Field name	***Description***
Name	Urban Planning data
Long name	Data of existing urban planning in Manresa
Description	Geodata base: Classification of soil (SU, SNU, SUP, SUNP) Areas of activity (partial plans, special plans, ...) Soil classification (rating and systems)
Author	Municipality of Manresa
Domain	Urban Planning data
Format	shape files (.shp) and database files (.sql)
Access type	by e-mail, may be web services
Date range	From 2008 to 2011

Field name	***Description***
Name	Public lighting
Long name	Geodata of public lighting
Description	Inventory and technical data of public lighting.
Author	Municipality of Manresa
Domain	Public lighting
Format	shape files (.shp) and database files (.sql)
Access type	
Date range	From 2008 to 2011

Field name	***Description***
Name	General Municipal Data
Long name	Socio-economic annual data of Manresa
Description	Demographic, GNB for Manresa, rent, incomes, number of households, household type, electrical appliances per type of household, type of families, number of occupants per dwelling, land prices, and other statistical data for all the districts of Manresa.
Author	IDESCAT, Catalonia Statistics Office, Municipal Statistics Office
Domain	Socio-economic data
Format	Excel files (.xls) or .pdf files
Access type	Download from web page
Date range	From 2008 to 2011