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SEMANCO Semantic Tools for Carbon Reduction in Urban Planning

SEMANCO

Deliverable 6.2
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DoW	**Task description** Identification of key parameters relevant to CO_2 reduction in urban development projects. Screening of a range of urban development projects with regards to the relative importance as well as political emphasis on the parameters determining the carbon footprint. This work will be used to further situate the analysis of the problem domain conducted in T6.1 within the analysis of how the tools developed in T 5.4 can be more generally applied. **Deliverable description** Report on key parameters: This report will situate the stakeholder requirements presented in of D6.1 within a wider context. To do so, it will compare them, to an analysis of current urban development projects within the EU with regard to the relative importance as well as political emphasis on the parameters determining the carbon footprint.				
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EXECUTIVE SUMMARY

This report presents the research conducted in Task 6.2 *Identification of key parameters relevant to CO_2 reduction in urban development projects.*

The main outcomes of the work carried out is the identification of key parameters relevant for CO_2 reduction in a range of urban development projects in the case study countries (Denmark, Spain and UK) in the context of the SEMANCO project.

Each participating partner – Ramboll, CIMNE and NEA/UoT – collected data from 3-4 urban development projects in Denmark, Spain and the UK respectively to identify the key parameters. Then each partner used a crib sheet to interview actors/users involved in each urban development project to identify requirements related to policy, data, stakeholders and technical issues in the urban development projects.

The key parameters and the requirements capture from the interviews lead to a set of recommendations and suggestions for practical application in the SEMANCO integrated platform. The main purpose of the exercise described above is to ensure that the scope of the platform and the tools developed goes beyond the three case studies in Copenhagen, Newcastle and Manresa. A summary of the key parameters and recommendations for the respective case study countries is given below:

Denmark

- The 3D model visualisation functionality would have added great value to the project in the planning/competition phase as well and could have been used to model and visualise energy demand and energy supply for the city/neighbourhood in great detail. 3D models for all 4 projects could potentially be introduced to the technological platform.
- In all four urban development projects the approach to determine the energy consumption and CO_2 emission for the urban area has been by working with energy intensities (e.g. same as specific energy demand for the North Harbour case study). The energy intensities for buildings may be different from project to project depending on the level of ambition for sustainability, construction period etc. However, the methodology applied is the same. This suggests that all four urban development projects will be able to use the UEP-tool developed in T5.4 if the stakeholders decide to make use of the technological platform.
- The possibility of defining different scenarios is already available through the technological platform using the UEP-tool including choosing energy supply technologies, specific energy demand for buildings and determining the effect on CO_2 emissions (as demonstrated in T8.3). However, the cost impact related to the scenarios is yet to be implemented and should be included in the technological platform in the further development.
- Other functionalities that are not implemented in the technological platform yet are the possibility of making projections in the scenarios using the UEP-tool. This is important in most green field projects, where stakeholders have committed themselves to low carbon emission (or in some cases even carbon neutrality) in the full life time of the urban development project and new buildings will be built covering the entire urban area.
- The functionality of reporting as an integrated part of the technological platform would have been very helpful in both the project planning/competition phase and in the project reporting phase for all four green field projects described. A brief report template with all relevant parameters and main analysis results, simple graphs and the 3D model itself would be of great value.

Spain

- Including the cost parameter in the analysis carried out using the tools developed to guide the decision making process is extremely relevant.
- When working with large urban areas introducing information at building level might become useless, as there is little level of detail and not very concrete. In these situations, the users of the technological platform may be able to identify energy intensities for large areas of urban development rather than identifying the exact building parameters. Options allowing this sort of information could be very useful in the technological platform.
- Since shadows affection has been seen as one of the most important parameters to be considered in the Spanish case when deciding between different urban structure options (it affects not only sun exposure but percentage of windows in facades and potential sun-depending energy systems), it has become important that the tool developed allows the user to easily interact with shapes of different building typologies, meaning rotation, movement, extrusion, etc. all within a nicely usable 3D environment.
- In most of the policies requirements addressed in the studied urban development projects, the CO_2 emission parameters identified seem to be the most transversal parameters, which could be used to compare with other policy requirements in other urban development projects. CO_2 related parameters will allow a comparison of the effect of CO_2 emission reduction policies (e.g. energy efficient urban lightning, mobility management etc.) across different urban development projects. It seems that this is one of the most important parameters which should be highlighted in a final report developed by the technological platform when the user has carried out an analysis using the tools developed.

UK

- There would be a clear additional functionality if it were possible to integrate costs (construction / refurbishment) into the platform, albeit this would be necessarily crude due to the actual availability and commercial sensitivity of accurate costs. While some large commercial databases on new building and refurbishment costs are available, there would be additional functionality within the technological platform if the relative cost impacts were able to be calculated.
- Many of the procedural concerns around a mix of formal statutory planning and informal community involvements would benefit from better visualisation and communication of the data. The provision of choice between 2D and 3D visualisation may aid the appropriate representation of different scales of socio-economic data sets.
- Lifestyle parameters that impact on household and area-wide CO_2 emissions perhaps present some of the most significant challenges for the development of the SEMANCO platform. Hence, the potential for the SEMANCO platform to extend the typical household income levels to make these sort of 'ecological foot printing' calculations could be considered where stakeholders have a particular interest in a more holistic approach to reporting overall resource consumption and carbon emissions.

The mapping of the key parameters relevant to CO_2 reduction and the requirements related to policy, data, stakeholders and technological development in a total of 11 urban development projects in the three case study countries, has confirmed the potential applicability of the SEMANCO platform and the tools developed, beyond the three case studies in Newcastle, Manresa and North Harbour. Even though this was assumed early on in the SEMANCO project it has now been validated by completing T6.2.

1 INTRODUCTION

1.1 Purpose and target group

As described in the DoW, the work to be developed in Task 6.2 is to situate "the analysis of the problem domain conducted in T6.1*Defining the problem domain and scope of the tools within the case study scenarios* within the analysis of how the tools developed in T 5.4 *Prototype of the integrated platform* can be more generally applied". The scope of the work is limited to identifying 3-4 new urban development projects for each case study country (e.g. Denmark, Spain and UK), which could be used as additional case studies to verify the applicability of the SEMANCO platform . Hence, the work in T6.2 provides valuable input to T6.3 *Developing the implementation strategies*, where a conceptual model of the tool implementation in WP8 will be developed, T7.4 *Exploitation planning* dealing with the creation of potential "spin-offs" initiatives originating from the project outcomes and taking the technological platform to potential new clients by those partners involved in energy-related planning and T8.4 *Analysis and conclusions of the implementations*, which is concerned with the comparison with other projects to verify wider applicability.

1.2 Contribution of partners

The three partners in charge of the case studies (FORUM, UoT, NEA and Ramboll) have mapped 3-4 urban development projects in Denmark, Spain and UK using a template and an interview form (crib sheet). FUNITEC has given input related to work carried out in T5.4.

1.3 Relations to other activities in the project

The illustration below shows the link between T6.2 and other tasks and work packages.

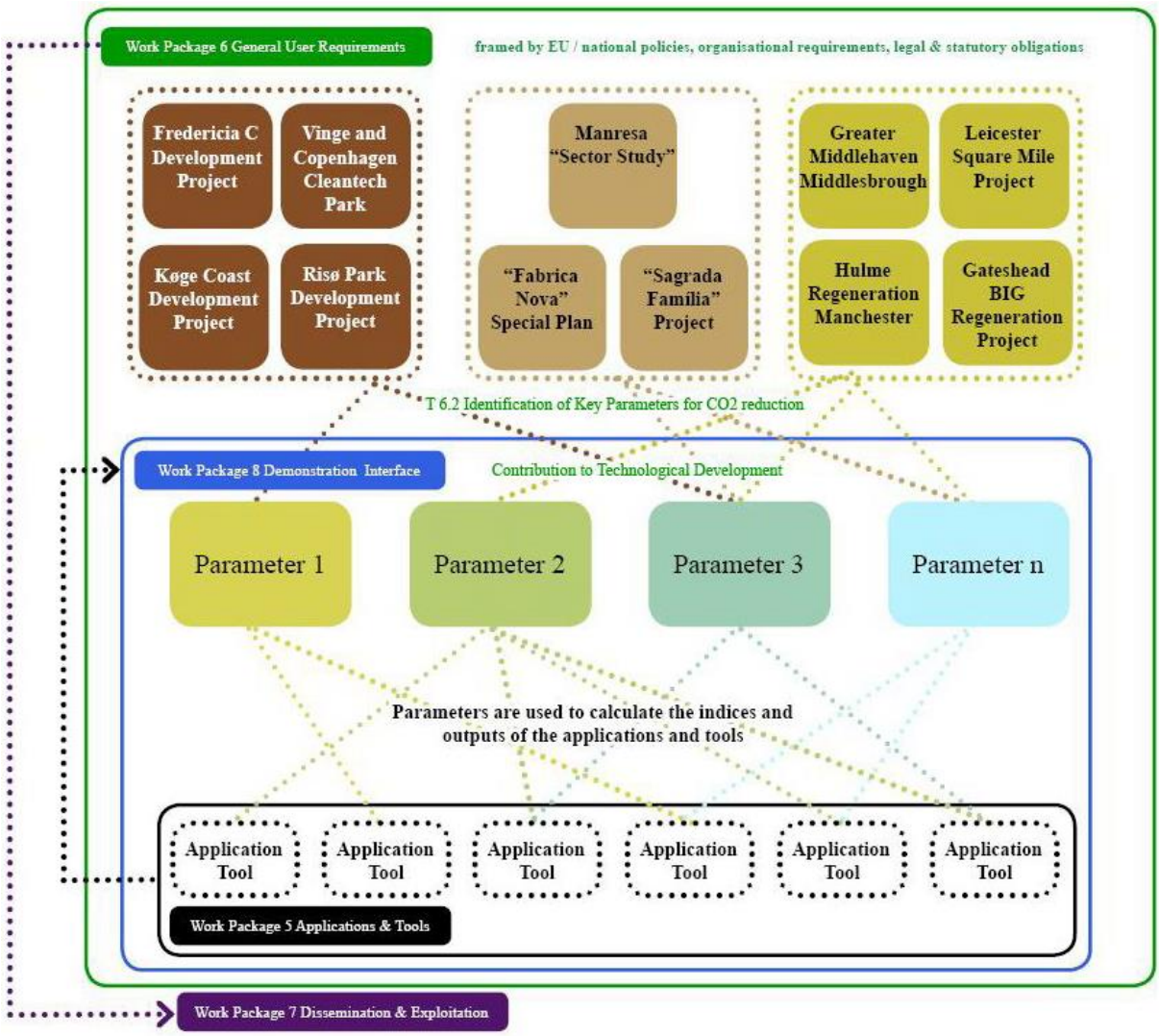

Figure 1. The relationship between the identification of key parameters relevant to CO_2 reduction in urban development projects under work package 6 and other SEMANCO work packages

Figure 1 depicts the relationship between the activities undertaken as part of WP6 and other project tasks. As it can be seen in the figure, the purpose of T6.2 *Identification of key parameters relevant to CO_2 reduction in urban development projects* is used to ensure the wider applicability of tools and functionalities developed in the technological platform and specifying other functionalities that could be introduced in the SEMANCO project life time or afterwards.

1.4 The structure of the report

The remainder of this report is split into six chapters. Chapter 2 describes the methodology used to capture the relevant key parameters relevant to CO_2 reduction and their relative importance and political emphasis from 3-4 urban development projects in each case study country (Spain, UK and Denmark). The chapter also includes the capture of policy, data, stakeholder and technological requirements for each project in the SEMANCO context. Chapters 3, 4 and 5 describe the application of this methodology for requirements capture in the Spain, UK, and Denmark. Chapter 6 summarises the findings. By way of conclusion Chapter 7 summarises the contribution of the work presented to the project's technical development and the demonstrations.

2 METHODOLOGY

2.1 Introduction

The methodology applied to complete this task was developed by following a step-by-step approach given below:

- Define the meaning of the term "key parameter" (T6.2) and the coherence with the term "indicator" (T2.2) in the context of the project.
- Determine the data collection method for identifying key parameters relevant to CO_2 reduction in urban development projects in the three case study countries. The aim was to identify a common approach suitable for case study countries (e.g. Spain[1], UK and Denmark[2]).
- Define the approach to determine the relative importance and political emphasis of key parameters identified from the urban development projects.

The outcome of the steps above is summarised in the sections below.

2.2 Difference between key parameter and indicator

From a brief desk study research it is evident that the distinction between the term "*indicator*" and "*key parameter*" is very little. One example is given below:

"A parameter is a numerical or other measureable factor forming one of a set that defines a system or sets the conditions of its operation" [Oxford English Dictionary].

"An indicator is a thing which indicates the state or level of something" [Oxford English dictionary]

The examples given above would suggest that a set of parameters would be able to explain for instance an urban energy system for a given urban energy model in a specific urban development project. Indicators, on the other hand, would be used to determine the state of the urban energy system that would change over time. These definitions fit nicely with the work carried out in T2.2 *Strategies and indicators for data modelling and data analysis* in the SEMANCO context where a set of indicators have been compiled for the three case studies in Spain, UK and Denmark describing the input needed to measure or calculate the indicators relevant for the specific case studies. The definitions also fit nicely with the work carried out in T5.4 *Prototype of the integrated platform*, where the concepts of urban energy systems and urban energy models were introduced and described in greater detail.

Hence, our understanding is that parameters **explain** a given urban energy system and indicators make it possible to **measure** the state of the urban energy system.

However, as with all forms of qualitative research that is seeking to draw conclusions and understanding from case study material, much depends on interpretation (Stake, 1995). We acknowledge, as with other studies (Baker & Wong, 2006; Astleithner, 2003), that the choice of parameters is politically subjective.

[1] In the case of Spain it was agreed that the approach would be to interview the person in charge of a the specific urban development project, and try to identify which parameters were included from the beginning in the decision making process , and which CO_2 related parameters were considered or missing during the process.

[2] The Danish understanding of sustainability related to energy consumption in urban development projects was examined to see if it was suitable for a common framework for this task

2.3 Data collection methods

The data collection to identify the key parameters relevant for CO_2 reductions in the urban development projects was conducted by studying the relevant project reports, through the information gather from the projects web sites or through meetings with stakeholders. Each participating partner – Ramboll, CIMNE and NEA/UoT – collected data from 3-4 urban development projects in Denmark, Spain and the UK respectively. Each partner used a crib sheet to interview actors/users involved in each urban development project. The crib sheet was divided into four sections, each with a set of questions exploring some relevant aspects of the urban development project which were relevant for the SEMANCO platform. The sections included in the crib sheet are:

- Policy Requirements
- Data Requirements
- Stakeholder Requirements
- Technical Requirements

An example of the crib sheet including questions is given below:

Table 1. Example of crib sheet used for interviews

Policy requirements
What motivated the development of the project? (For example, was this a political decision or was it due to political, social, technical pressures? Who initially commissioned the work?
We are interested in the background policy requirements (parameters / indicators) for the project. How did / does the local level policy compare / differ from national / international policy frameworks? Were you working to higher standards than required by building regulations, National Planning Policy Framework / PPS required you to at the time?
Was there some specific local policy conditioning this urban development? During its development, did the project create a new local policy applicable to other urban projects or areas of the city?
Was there anything directly relevant to the project from national legislation (for example; NI186 reporting on carbon reduction; Sustainable Energy Act 2003 / Energy Act 2004 / 2013; Housing Act 2004; Climate Change Act 2008; Heat and Energy saving Strategy)?
What were the most significant aspects from local requirements (for example; Planning policies? Were these local policies supportive of or prohibitive to the project aims and objectives? How did they help? How did they create barriers to the project (for example; time delay, lack of skills / knowledge, additional cost)?
Were there any specific funding requirements or grant conditions that impacted upon the project specifications?
Were there any other economic issues beyond your control which had an impact upon your programme?
Which of these conditions were statutory / mandated or recommended?
What background evidence was in place to support this local policy (for example; planning / public enquiry processes)?
Data requirements
Which data sets have you used during the project? Where does it come from? Has the project developed any new datasets?
We are interested in how you assessed the project against the range of policy and grant requirements.
What was the scope and scale of data required by the project (for example; energy demand; local energy resources / potential; potential energy savings; cost of energy savings / supply / district heating; potential reduction in carbon emissions)? What was the source of this data (for example; bespoke commissioned / open source)? If it was commissioned, is this available for reference? At what stage in the project was it used and was it fit for purpose (for example; in setting the brief, business planning, design, options testing, monitoring)? What were the benefits and / or limitations of the data available (for example; cost, timing, delays, and accuracy)?

Did you adapt the project parameters and requirements in any way in response to the availability or cost of data?
Stakeholder requirements
We are interested in the range of stakeholders (actors and users) involved in the project. Who was involved in the decision-making process and at what stage in the project process? What were the formal decision-making arrangements or structures for the project (for example; project management arrangements; steering / advisory group; consultation exercises; peer-review / design review exercises)? At what project stage were different stakeholders involved? For each of the following generic project stages map out stakeholder involvement – preparatory stages (project initiation, business planning, procurement strategy), design stages (outline / draft design, options appraisal, detailed design), construction (quality control), post construction / occupation (management, monitoring)? How were information / evidence used to inform these decision-making bodies? What distinctions were made regarding technical and non-expert stakeholders? What is the paper trail for the project? Are there minutes, records or similar accounts available for the key decision-making stages throughout the project?
Technical requirements
We are interested in the type of assessment, evaluation, design, modelling and monitoring tools and functionalities required to support the project. In the project were you involved in commissioning, using or responding to technical reports? What was the extent of ICT / software usage to support the different stages of the project? What tools were used? What is your experience of these strengths and limitations? What could be improved (for example; format, accuracy, costs, speed, platform, transferability, limitations – insert reference stakeholder capture requirements table)?

Each partner - Ramboll, FORUM and NEA/UoT - has tailored the crib sheet according to their requirements and filled out the crib sheet forms for 3-4 urban development projects (cf. Appendix 9).

2.4 Methodology to identify relative importance and political emphasis of key parameters

The key parameters identified in the urban development project are evaluated according to their relative importance and political emphasis.

The political emphasis in each urban development project is identified through a study of the local policies and context in the specific project as perceived by the stakeholders (actors and users) involved in the project. Hence, whilst the most important policies related to energy efficiency and carbon reductions in urban development projects from a national, European or international perspective were identified in D2.1 this study takes a more local perspective. Nevertheless, even though national and international policy context obviously influence the local perspectives, sometimes new urban development projects are more ambitious and innovative (e.g. carbon neutrality from the beginning, 100% local renewable energy supply etc.) and can be used to demonstrate best practice solutions in a showcase for sustainable urban development.

Table 2. Framework for defining and recording political emphasis and relative importance

Recording of key parameters impacting on energy efficiency and carbon emissions		
Key parameter	**Political emphasis**	**Importance**
Key parameter on energy efficiency or reduction of carbon emissions raised by	High - Statutory requirement / mandated. Evidenced through a combination of national primary legislation and / or local statutes, (including local planning DPD /	Interviewee's option of the relative importance of this issue / parameter regarding actual impact on improving energy

interview subject.	LDFs and variations to Building regulations. Medium - Incentivised requirements. Funding / grant condition. Evidenced through copy / reference to grant / contract or tender requirements. Low - Advisory / recommended. Actions promoted through guidance, best practice studies and peer-review.	efficiency and / or reducing carbon emissions.

It could be argued that "political emphasis" is (or should be) the same as "relative importance". However, this is not always the case. Usually political emphasis is based on visions or long term local or national policies and strategies (e.g. Covenant of Mayors, national energy and climate change strategies) which are target oriented (e.g. 20% reduction in 2020, independence of fossil fuels). Ideally, from an analysis point of view "relative importance" of parameters should be based on a qualitative/quantitative analysis of the parameters addressed. These types of analyses are not always carried out in the planning phase of an urban development project, but have the potential of guiding and even changing the "political emphasis" when addressed.

The methodology followed to assess "political emphasis" and "relative importance" of parameters has been to collect data for each urban development project listing already identified parameters and asking key stakeholders (actors and users) involved in the project to rank each parameter's "relative importance" and "political emphasis" as "low", "medium" or "high".

The parameters have then been illustrated by using the following diagram (Figure 2) for each urban development project screened in the mapping exercise in UK, Spain and Denmark:

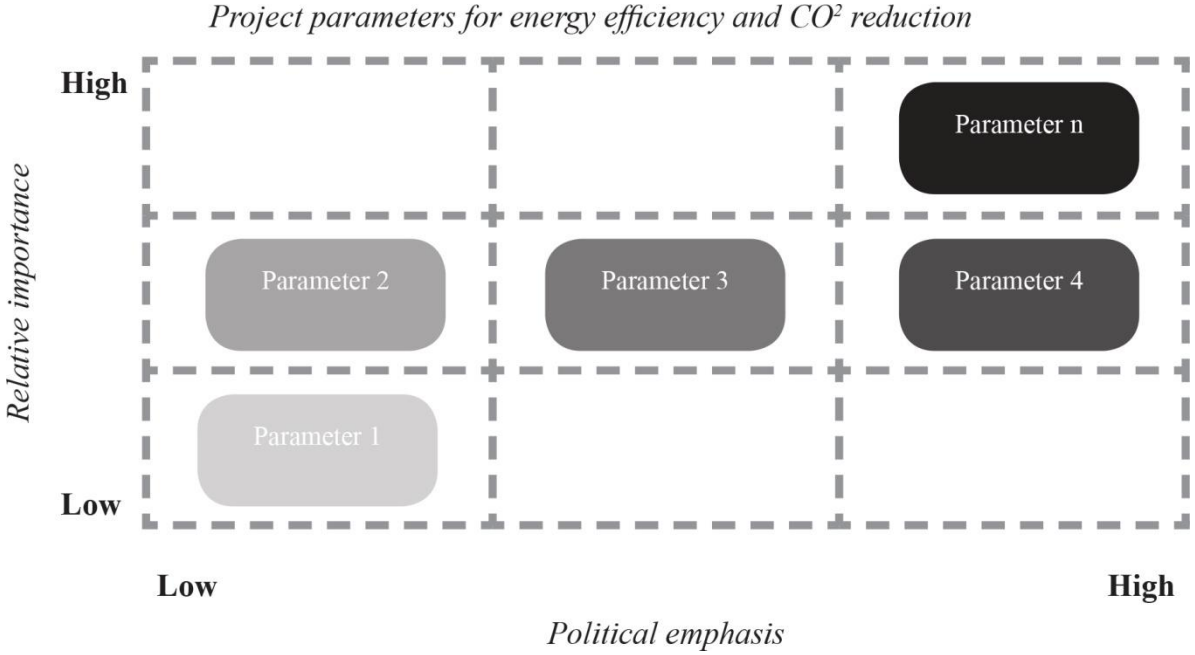

Figure 2. Diagram to illustrate relative importance and political emphasis of identified key parameters relevant for CO_2 reductions in urban development projects

3 REQUIREMENTS CAPTURE IN DENMARK

3.1 Introduction

Urban development projects are often split into two main categories. One category is urban development renovation projects where buildings and entire neighbourhoods are renovated in order to lift the social status of the neighbourhood itself and improving the energy performance and carbon footprint of buildings at the same time. The other category is urban development green field projects, where a new city or neighbourhood is to be built and will be developed for the next many years.

Both types of projects often involve the same type of stakeholders (e.g. project developers, architects, engineers, construction companies, utility companies etc.). However, the main difference between the two types of projects is the level of ambition in the field of sustainability since a green field project allows for sustainability features (social, environmental, economic) to become an integrated part of the project from the beginning.

The urban development projects considered are all green field projects similar to the North Harbour case study. This scope has been chosen intentionally making it possible to more directly address the applicability of tools developed in T5.4 to other newly developed urban projects.

3.2 Brief descriptions of urban development projects

The urban development projects addressed in the Danish case are all projects that Ramboll has worked on as energy consultants. This has made it easier to identify the key parameters relevant to CO_2 reduction and the data to support it.

The urban development projects are the following:

- Vinge and Copenhagen Cleantech Park, Municipality of Frederikssund
- Køge Coast, Sustainable Urban Development
- Fredericia C, the Amsterdam of Jutland
- Risø Park - development of a Science Park at DTU Risø Campus

A brief description of each of the projects is provided next.

Vinge and Copenhagen Cleantech Park, Municipality of Frederikssund

The main objective of this project has been to develop energy supply scenarios for the energy infrastructure and to propose a sustainable transport and drainage/water supply infrastructure for the new city Vinge and Copenhagen Cleantech Park (CCP) at St. Rørbæk in collaboration with commercial and government partners (Figure 3).

The purpose of the energy supply scenarios has been to come up with proposals for a relevant energy infrastructure for Vinge and CCP from a socio-economic point of view addressing the goal of CO_2 neutrality envisioned by the Municipality of Frederikssund.

In the project three different energy supply scenarios were identified and analysed:

• Decentralised energy supply (at building and land use level)
• Central energy supply (through establishment of/connection to central heating and electricity grids)
• Semi-decentralised energy supply (at village or cluster community level)

The scenarios represent relevant alternatives of energy supply that all municipalities in practice have to decide upon in the municipal energy planning process. Possible interactions and

synergies in the energy supply system from a wide variety of both conventional and new energy technologies on the market have been analysed, with particular focus on security of supply, economic viability, flexibility and potential for energy storage. Each energy supply scenario includes an assessment of the individual energy technologies based on the technological stage of development.

Figure 3. Map showing the green field Vinge and Copenhagen Cleantech Park area

Køge Coast, Sustainable Urban Development

The vision for Køge Coast (Figure 4) is to create a unique, attractive and sustainable community that strengthens Køge's role as a centre in the metropolitan area, in Zealand and the total region. The vision focuses on these six issues: culture, retailing, infrastructure, creativity and quality, public involvement, sustainability.

The Municipality of Køge and a private development company have joined forces in a partnership for the Køge Coast project.

In this project sustainability covers both environmental and energy-related factors, for example in the form of compact residential construction, which provides a range of environmental benefits. Moreover, the urban development project will be carried out on a sustainable basis from the perspectives of health and social welfare.

The expected CO_2 emission 2010 - 2030 has been estimated from the energy strategy chosen which combines a selection of the most flexible and economically viable measures available to reduce CO_2 emissions.

Figure 4. Map showing the existing city and the new Køge Coast area

Fredericia C, the Amsterdam of Jutland

One of main features of the plan of Fredericia C –which occupies an area of 204.345 m^2– are the new canals that will open the area to the Little Belt (sea) and will bring the water all the way into the town (Figure 5). Other characteristics of the plan are:

- It is both compelling and innovative as well as respectful of the old part of Fredericia
- It lets the quality of life go hand in hand with great quality in town building keeping a keen eye on tomorrow's possibilities
- It seeks active participation from the citizens, commerce and culture in Fredericia as an asset and as a necessity for good development
- It creates a new role for Fredericia as a key player in the Trekantsområdes (region) competition with Copenhagen, the capital of Denmark
- It incorporates state of the art sustainability in economy, climate and health in both planning and solutions

The development plan is based on a fundamental principle: that the development of Fredericia C must be sustainable in the broadest sense of the word, i.e. in relation to the environment, energy and climate, health and social issues as well as financially. The ambition is to set new standards for urban development in Denmark in the following way:

1. Fredericia C will take steps to create a carbon-free urban district and will therefore demand low-energy buildings and supply of alternative energy sources, such as surplus heat and photovoltaic cells (PV-systems).

2. A mix of housing types, retail outlets, cultural offerings, etc. will contribute to creating a diverse and inclusive urban district with room for everyone. At the same time, the urban district will encourage play and movement and, in that fashion, contribute to improving health.

3. The development of Fredericia C must also be financially viable and, in addition, the project must meet an imperative requirement of high quality.

The chosen energy strategy related to step 1 above combines a selection of the most flexible and economically viable measures available to reduce CO_2 emissions with a balanced focus on reduced demand and sustainable energy supply.

Figure 5. Map showing the existing city and the new Frederica C area

Risø Park - development of a Science Park at DTU Risø Campus

The Risø Park project is the development of a Science Park at DTU Risø Campus (Figure 6). The science park is meant to make new links between research institutes and businesses with access to unique test and demonstration facilities. The aim is to become Europe's leading research and business cluster for clean tech companies.

The vision of the park is to become a reference that can help realise the vision of Denmark as a green growth laboratory. The aim is that the science park and the interaction with Risø, Roskilde University, other knowledge institutions and a wide range of companies in the energy, environment and climate industries will be able to create a Danish showcase of the latest technologies, smartest processes and the most sustainable solutions.

The purpose of the energy scenarios has been to come up with a proposal for a relevant energy infrastructure for Risø Park from a socio-economic point of view addressing the goal of keeping the CO_2 emissions as low as possible. Furthermore the purpose has also been to investigate new combinations of energy supply technologies, examples include district heating in combination with very large decentralised heat storages.

In the project three different scenarios for the energy supply were identified and analysed:

• District heating with supply from the local district heating company in Roskilde
• Central energy supply (through establishment of/connection to central heating, large heat storages, large heat pumps and electricity grids)
• Decentralised energy supply (at village or cluster community level) in particular focusing on solar heating and wind turbines

The scenarios were furthermore compared to a baseline scenario with natural gas as fuel, and with another scenario using low-energy buildings to minimise the energy consumption instead of using alternative energy in the energy supply.

The scenarios represent relevant alternatives of energy supply that all municipalities in practice have to decide upon in the municipal energy planning process. Possible interactions and synergies in the energy supply system from a wide variety of both conventional and new energy technologies on the market have been analysed, with particular focus on security of supply, economic viability, flexibility and potential for energy storage. Each energy supply scenario includes an assessment of the individual energy technologies based on the technological stage of development.

Figure 6. Architectural image of the Risø Park area

3.3 Key parameters relevant to CO_2 reduction

Each of the projects listed above have been studied according to the method described in chapter 2. The key parameters relevant for CO_2 reduction identified in the context of the urban development projects in Denmark are described below:

Table 3: Key parameters relevant for CO_2 reductions in Danish urban development projects

Nr.	Key parameters related to carbon reductions	Description
1	The energy intensity for new buildings in urban area development	In many green field urban development projects in the Danish context the debate is related to the socio-economic benefits in applying the strict building codes (expected to be introduced in 2015 and 2020) giving very low energy demands and forcing buildings to be equipped with decentralised energy systems compared to central district heating. This will very often be based on cost benefit analysis determining the optimal combinations of measures regarding sustainable energy supply and energy savings, with the lowest possible costs
2	Performance specifications for energy consumption in the buildings, such as specifications for Energy Class	The energy consumption in new buildings is regulated by the Building Regulations. As a minimum a building has to comply with the Building Regulations 2010 Energy Performance Class. In the District Plans the municipalities are able to demand Low Energy Buildings, i.e. Energy Performance Class 2015 or 2020
3	Energy producing buildings	Buildings producing electrical power with for example PV systems are in some periods producing more energy than needed in the building. It is important that these buildings have the opportunity of selling the surplus energy to the grid.
4	The energy supply technology (e.g. building level, neighbourhood level, district level)	Depending on the building typology and building codes chosen the actors/users have to choose relevant energy supply technologies at building level, neighbourhood level or district level. This will very often be based on cost benefit analysis determining the optimal combinations of measures regarding sustainable energy supply and energy savings, with the lowest possible costs
5	Form and orientation of buildings	Certain renewable energy technologies at building level (e.g. PV-systems, solar collectors, micro windmills etc.) require an optimal orientation of buildings and/or angle of roof etc. (e.g. in the Danish context the optimal orientation for PV-systems would be facing south at an angle of 38°).
6	The characteristics of the buildings' fabric (e.g. U-values of walls, roofs, basement, windows, doors, percentage of glass, losses etc.)	The future strict building codes require very energy efficient buildings. It is however possible to compensate by installing renewable energy technologies at building level (e.g. PV-systems on roof tops) to compensate for energy losses due to large glass facades in buildings. This also affects the dimensions of the PV-system to be installed.
7	The number and type of electrical appliances (e.g. refrigerator, stove, TV, computers etc.) and systems (e.g. ventilation, lighting, pumps etc.) for a standard house or office	The number and type of electrical appliances are not regulated by the Danish building codes, whereas the energy consumption of fixed installations (e.g. ventilation, lighting etc.) is included. In the last decades the trend in typical households and offices has been an increase in number of both traditional appliances (computers, TVs) and new appliances (Ipads, smart phones, internet routers etc.). This gives a great challenge in managing the electricity consumption. In many urban development projects where CO_2 reductions are considered it is recommended that electrical appliances are energy efficient and considered to be Best Available Technology (BAT).
8	The consumer energy consumption behaviour	In many urban development projects there is a risk of underestimating energy consumption because of lack of knowledge of consumer behaviour. This is an important issue in especially low energy consuming houses (e.g. 2015 and 2020 building codes in Denmark) because the energy systems (heating and fixed electrical systems) are very often dimensioned to meet the requirements in the strict building codes and therefore under-dimensioned. This very often creates problems on the heating side if individual heating systems are installed without a grid connection (as opposed to district heating) without a sufficient buffer. It is less critical on the electrical side because most energy supply technologies (e.g. PV-systems) are grid-connected.

Nr.	Key parameters related to carbon reductions	Description
9	The dimensions (e.g. capacities, size, volume etc.) and energy supply technologies and components	The exact dimensions and capacities of energy supply technologies and components can be determined once the final energy supply strategy has been decided.
10	The land use for energy supply technologies and components	Energy supply technologies and infrastructure require the use of land at e.g. building level, neighbourhood level or district level. At building level it could be the land use for the pipes in the soil for the fluid-based heat pumps, at district level it could be a district heating infrastructure. Also there may be a need to place a heat accumulator inside a building or at district level which requires land use as well. Especially land use for onshore windmills often is a key issue in urban development projects due to the impact on nature and environment. Other plants such as large scale solar heating, biogas and biomass plants also require land use, which has to be considered in the urban development project. Transport corridors to and from plants with e.g. fuel also needs to be planned and requires land use. Usually large scale plants and components are placed in industrial areas and not inside residential areas.
11	The potential for renewable energy sources	In many urban development projects a study is carried out to determine the availability of local renewable energy sources in the area/region. This could be mapping of wind resources, biomass from animal waste and waste water to be used to produce biogas.
12	The CO_2 emissions for a given heat production technology	The fuel and technology used to produce the energy has great impact on the CO_2 emissions.
13	The CO_2 emissions for a given geographical urban development area	Many cities and municipalities have signed political agreements (e.g. Covenant of Mayors) where they are obliged to map CO_2 emissions for a base year and every second year after that.
14	The energy consumption and CO_2 emissions in a baseline scenario	The signatories of Covenant of Mayors have committed themselves to reduce CO_2 emissions by 20% in 2020 compared to a base year. In this regard it is important to conduct a baseline scenario where the effect of already decided measures and policies at a national and local level are included. This makes it easier for cities and municipalities to plan for additional measures.
15	The effects of different CO_2 reducing measures in a scenario	The cities and municipalities that have signed the Covenant of Mayors need to submit a Sustainable Energy Action Plan (SEAP) with CO_2 reducing projects and measures for relevant sectors (e.g. Buildings, Industries etc.) giving a 20% reduction in 2020.
16	Consumer energy price for heating and electricity	In general the consumer energy price for heating and electricity has to be competitive compared to the market situation. The costs of implementation of energy supply based on renewable energy (e.g. windmills, biomass plants etc.) is determined in relation to the expected ambition level for CO_2 targets. The price per kWh for the chosen energy supply solution is calculated on the basis of the combined investment costs, net present value of the operating costs over a 20 year period, including subsidies in the period in relation to the expected production.
17	Socio-economic costs for energy supply solution	In general there must be an estimation of the overall evaluation of the social economic effects of the chosen energy supply system. The estimation is based on the value of the socio-economic positive effects and the value of the negative effects along with an interest rate to calculate the net present value of the investments in the energy supply system over a 20 year period.

Nr.	Key parameters related to carbon reductions	Description
18	Municipal costs for chosen energy solutions and options	In general there must be an overall evaluation of the local economic effects of the chosen energy solutions and options. Local economic effects are not necessarily negative since the neighbourhood, municipal or regional stakeholders are expected to play the role of framework creators, facilitators or partners. The investments could be provided by private investors and consumers. However, there should be expected increased investment costs for the local stakeholders e.g. in infrastructure, information, and subsidies.

A total of 18 parameters are included in the table above. Even though the parameters are the same for all four urban development projects the political emphasis and relative importance has been perceived differently by stakeholders each projects. This is illustrated in the diagrams below (Figure 7-10).

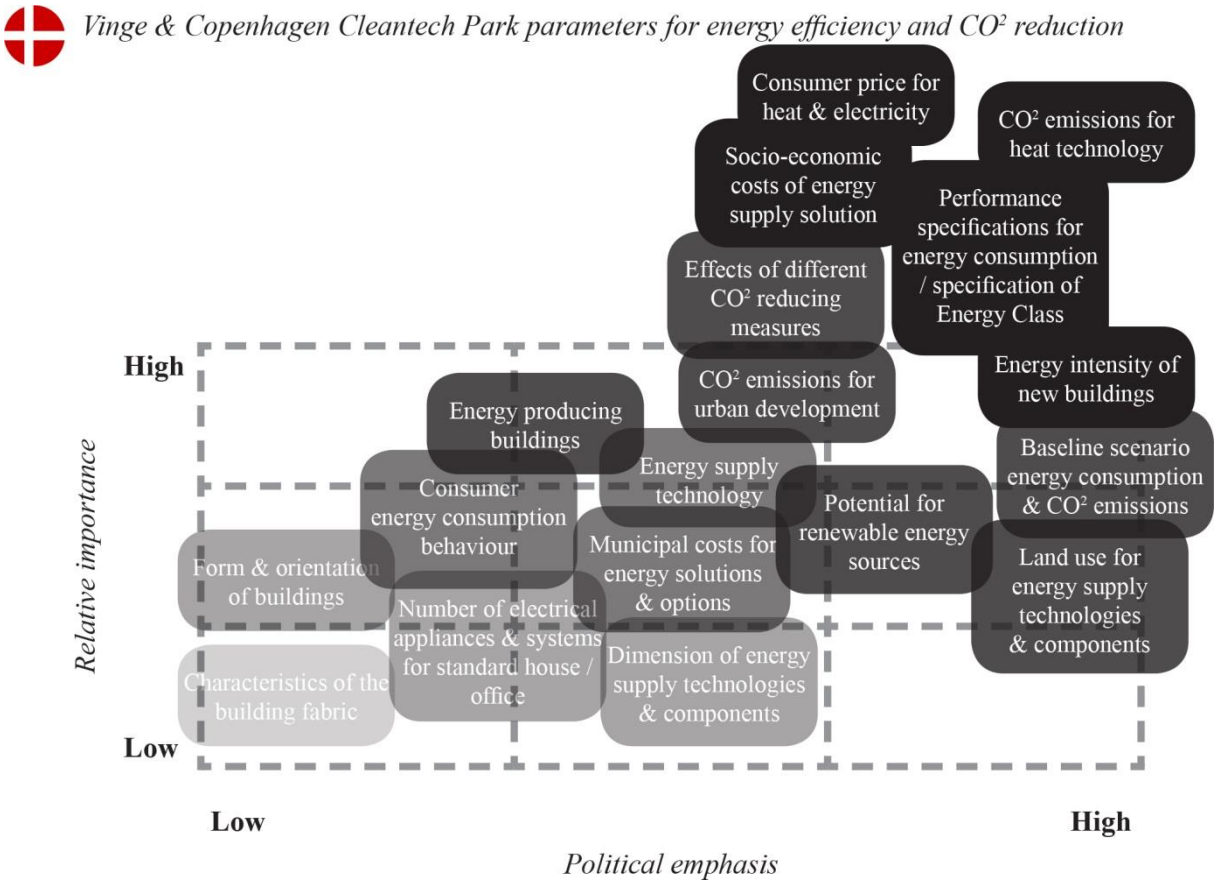

Figure 7. Relative importance & political emphasis of carbon reduction parameters for the Vinge & Copenhagen Cleantech Park

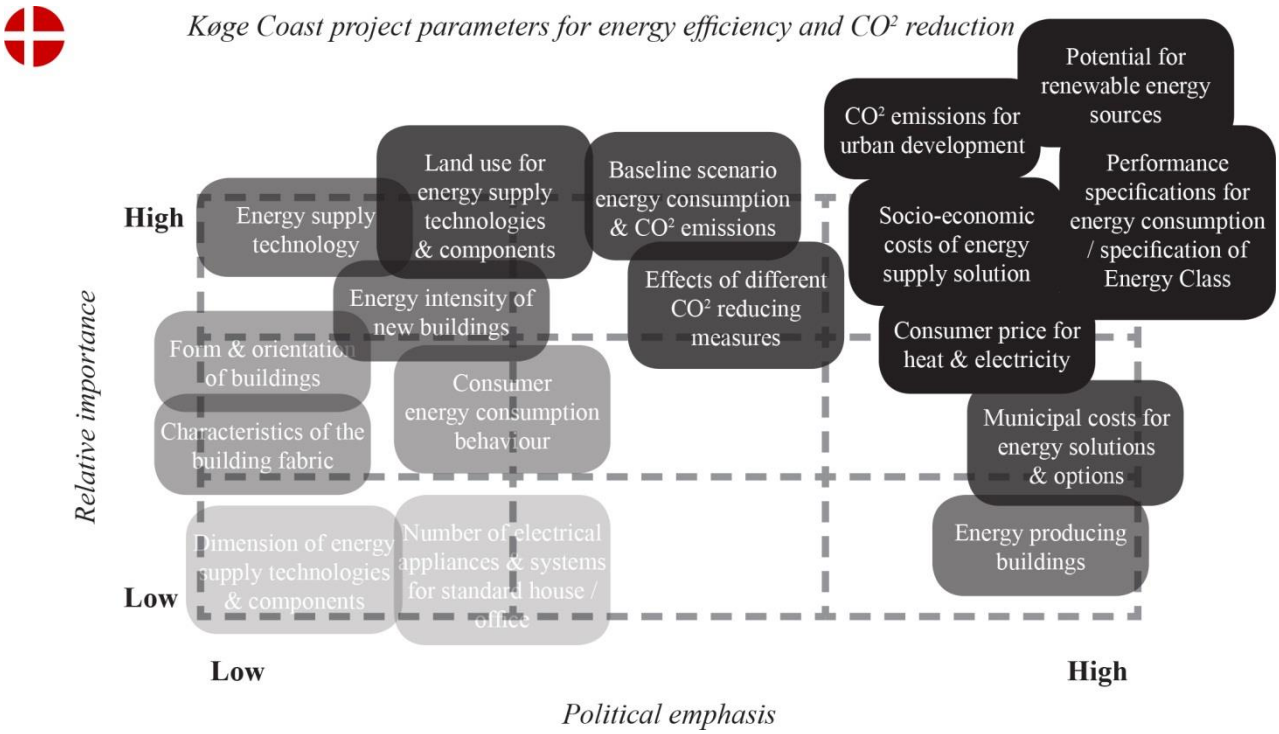

Figure 8. Relative importance & political emphasis of carbon reduction parameters for the Køge Coast project

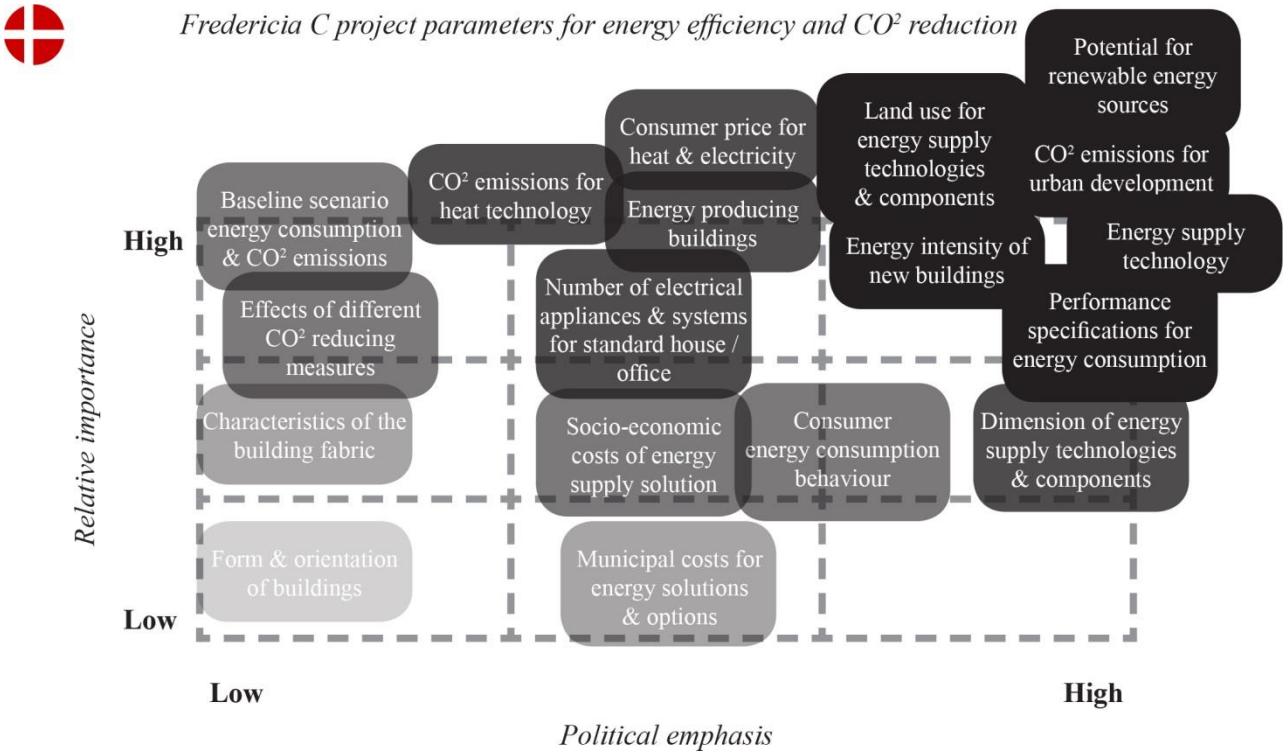

Figure 9. Relative importance & political emphasis of carbon reduction parameters for the Fredericia C project

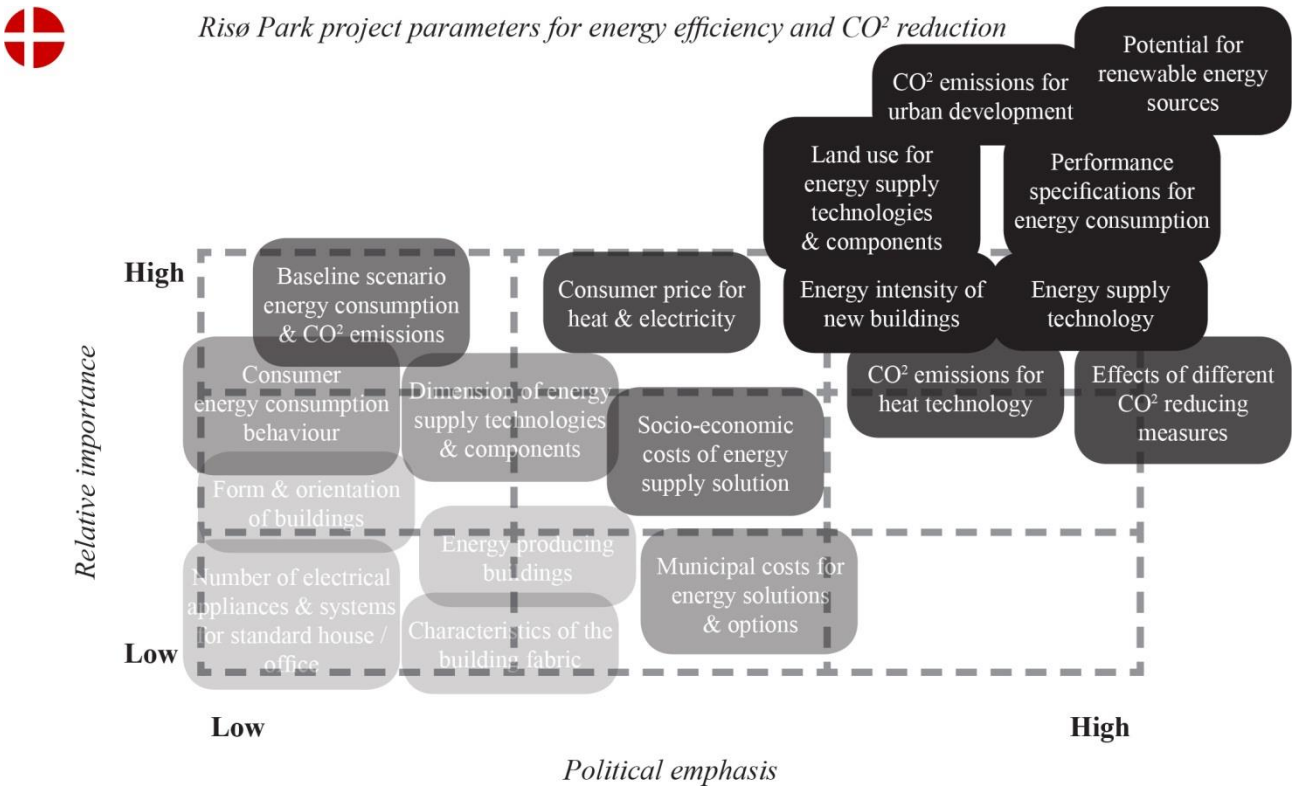

Figure 10. Relative importance & political emphasis of carbon reduction parameters for the Risø Park project

3.4 Contributions to the technological development

The following section summarizes the contribution to the development of the technological platform which can be derived from the analysis of the parameters collected in the previous section and from the interviews gathered through the crib sheets (cf. Appendix A1):

- All four urban development projects could be included in the technological platform at a later stage and would benefit from the 3D model visualisation functionality. The 3D model could have added great value to the project in the planning/competition phase used to model and visualise energy demand and energy supply for the city/neighbourhood in more detail. The creation of the 3D models of the urban developments in the technological platform could be possible through a joint effort made by architects, energy consultants and other SEMANCO partners.
- In all four urban development projects the approach to determine the energy consumption and CO_2 emission for the urban area has been by using the energy intensities method (e.g. same as determining "specific energy demand" in the North Harbour case study). The energy intensities for buildings may be different from project to project depending on the level of ambition for sustainability, construction period etc. However, the methodology applied is the same. This suggests that all four urban development projects will be able to use the UEP-tool developed in T5.3 if the stakeholders decide to make use of the technological platform.
- In general stakeholders in green field urban development projects require a description of the parameters that could have a decisive impact on reducing CO_2 emissions from the beginning of the project. The parameters then have to be further analysed in a set of different scenarios illustrating the energy performance, share of renewable energy, cost etc. In the end the most cost-effective scenario is most likely to be chosen and implemented in the project implementation phase.
- The possibility of defining different scenarios is already available through the technological platform by using the UEP-tool, including choosing energy supply technologies, specific energy demand for buildings and determining the effect on CO_2 emissions (as demonstrated

in T8.3). However, the analysis of the cost impact for a given scenario is yet to be included and implemented in the technological platform.

- Other functionalities yet to be implemented are the possibility of making projections in the scenarios. This is important in most green field projects, where stakeholders have committed themselves to low carbon emission in the full life time of the urban development project. The relevant projection in the case of Denmark (and maybe the rest of EU) would be up to year 2020, 2030, 2035 and 2050 due to ambitious national policies as suggested in D2.1. Hence, it would add great value to the technological platform, if functionality is added, that could project and illustrate energy consumption and CO_2 emissions for the entire city/neighbourhood for a certain period in time.
- One of the strong features of the LEAP-model is the reporting functionality, which has been used in most of the projects described. This functionality is very useful when engaging with stakeholders at meetings etc. However, since the LEAP-model does not have a 3D model of the urban area the functionality of reporting, as an integrated part of the technological platform, would have been very helpful in both the project planning/competition phase and in the project reporting phase for all four green field projects described. The reporting functionality could include a brief report template presenting all relevant parameters and main analysis results, simple graphs and screen shots from the 3D model itself.

4 REQUIREMENTS CAPTURE IN SPAIN

4.1 Introduction

In the national context of Spain, urban development projects are those which are developed under the regional legal framework. Their development is lead usually by an architect or by a group of architects, closely supported by a large spread of technicians with different areas of expertise.

The largest projects are those which are commissioned and supervised by the regional government. They provide the objectives towards a defined vision of the territory. The next level of urban development falls into the competences of local authorities. Municipalities are in charge of developing and maintaining a live document named Urban Master Plan. This document guides all urban developments within the boundaries of each Municipality, and identifies where more in-depth urban development projects are needed.

4.2 Brief descriptions of urban development projects

The urban development projects studied in the Spanish case have been selected among those recorded in the Manresa municipality archives. Urban developments at upper levels (regional level) have not been considered because of the fact that the impact of buildings in those developments decreases compared with other parameters such as mobility and land consumption, etc.

Three different projects with different aims and also different stakeholders have been selected for the purpose of this document.

- New development in a green field area, surrounding the current urban structure of the city. This is **Sagrada Familia Partial Plan**, Municipality of Manresa. The document has been commissioned and written by the Municipality and by its own urban planning department.
- Large refurbishment of an already existing old industrial area. This is **Fàbrica Nova Especial Plan**, Municipality of Manresa. The document has been commissioned by private companies (owners) and written by a group of architects from outside of the Manresa case study.
- Definition of areas of interest at city scale. This is **Sector Study work within the context of the Urban Master Plan of the Manresa revision**. This work has been commissioned by the Municipality and is being conducted by a leading team of architects from outside of the case study together with local technicians.

A brief description of each of the listed projects is available below. They are ordered from small to larger scales.

Sagrada Familia Partial Plan

This Partial Plan develops an area of special interest in the eastern part of the city. This area was pointed out in the 1997 Urban Master Plan as an area of special interest (Figure 11). The Urban Master Plan foresaw the development of this area during the first quadrennial, which was between 1997 and 2001.

The justification for this development is based on the need of releasing residential soil in order to further develop housing policies, and also for the creation of the public spot to place future educational institutions.

This special interest is due to the fact that it is predicted as one of the areas where the near future of the city will be located.

The general use fixed for this area is for residential purposes, although one of the most

important issues to solve is the connection of streets and the definition of a lineal green park surrounding an old irrigation canal.

There are 30 different properties, owned by a group of 18 different stakeholders, and the formal process for the development of this area is named "by cooperation", meaning that all the owners involved proportionally share all the rights and duties of the development, but the public administration takes care of and leads the process.

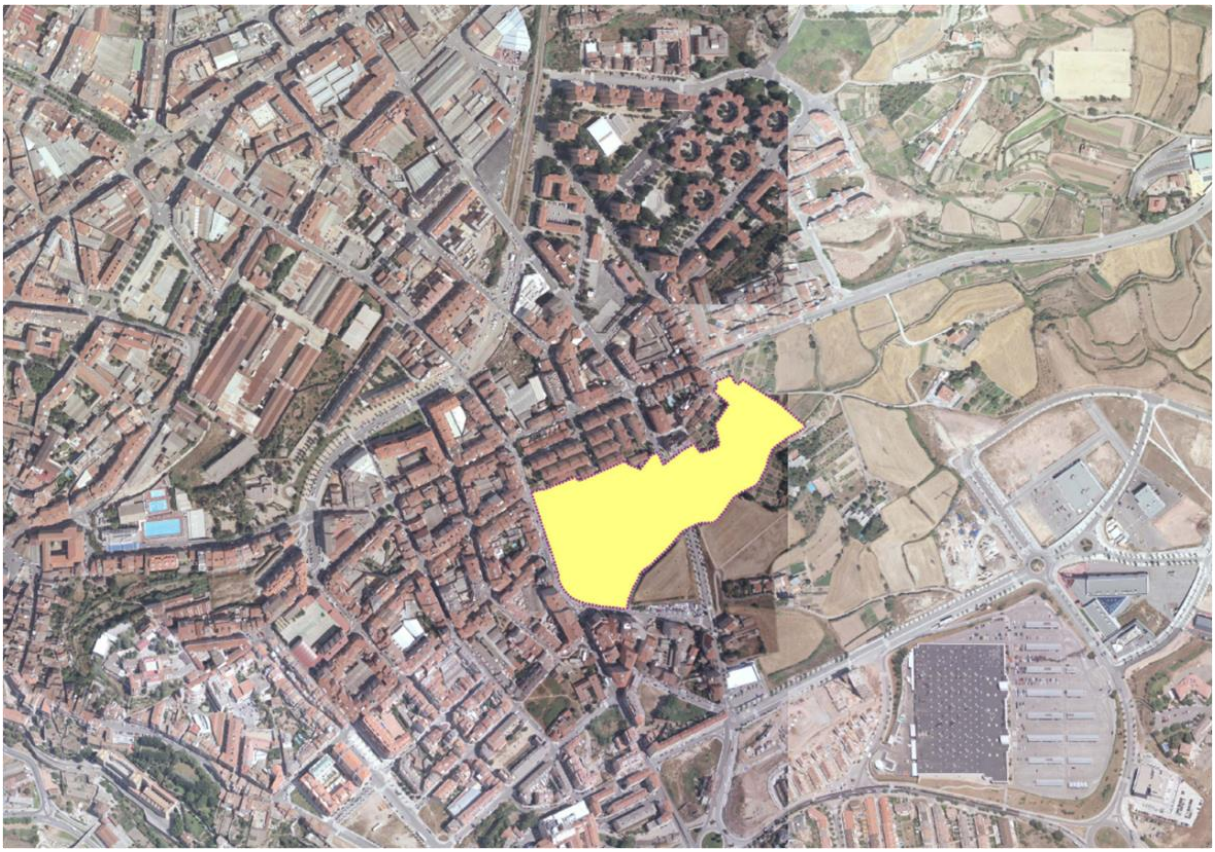

Figure 11. Aerial image of the area Sagrada Familia Partial Plan

Fàbrica Nova Especial Plan

The plan is categorised under the name of “Pla Especial Urbanístic” meaning “Special Urban Plan”. This juridical term of urban planning is used in certain areas where the Urban Master Plan has considered that a further development and justifications regarding the proposed urban structure is needed (Figure 12).

In this particular case, the limits of this urban plan deals with an ancient industrial sector, for a total area of around 69.000 m² and originally filled with the buildings of one of the largest textile manufacturers of the central region of Catalonia. The Urban Master Plan defines this Special Urban Plan as a key strategic urban transformation for the city, due to its location, shape and size, representing a huge opportunity, especially for improving the following urban indicators:

- Open public urban spaces

- Urban network of public facilities

- Economic activity distribution (tertiary)

- Integration within the limits of the Old City

There is also a particular building which has to be maintained due to its historical value. (Industrial modernism)

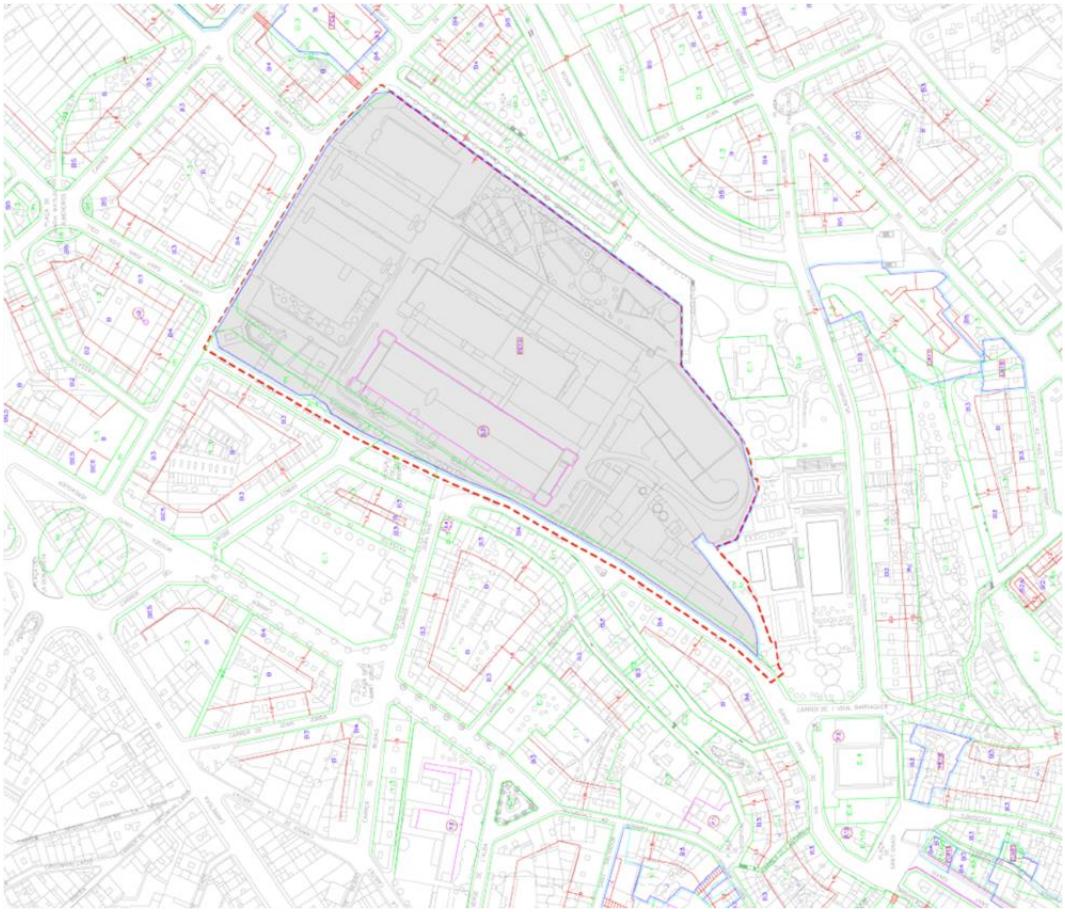

Figure 12. Blueprint image of the area Fàbrica Nova Special Plan

Sector Study, Urban Master Plan of Manresa revision

The type of work described here is the one that can be undertaken by a Municipality at a larger scale nowadays in Spain. The POUM (Pla d'Ordenació Urbanística Municipal or Municipal Urban Master Plan) is a holistic work involving the entire city. The work is meant to be done every 10-15 years and it is undertaken by the municipalities with the objective of redefining the guidelines for the development of the future city. The whole completion of the final work (a lot of time is spent on administrative mid-term approvals) lasts for almost 3 years. The project has currently reached the middle of the second year.

The plan offers the opportunity to rethink the urban development according to current policies, social and economic circumstances, the current structure of the city, the behaviour of main stakeholders during the last years, mobility issues, historical unsolved problems, demographic projections, foreseen future changes, etc. (Figure 13).

Within this line of work, the planning team in charge identifies and classifies future growing spots (green fields), but also areas of special interest in which many decisions can be made. Just for this fact, the POUM is a great opportunity either for the city or for private stakeholders to change the urban plans of concrete areas which, due to several different circumstances have not been developed as previously planned.

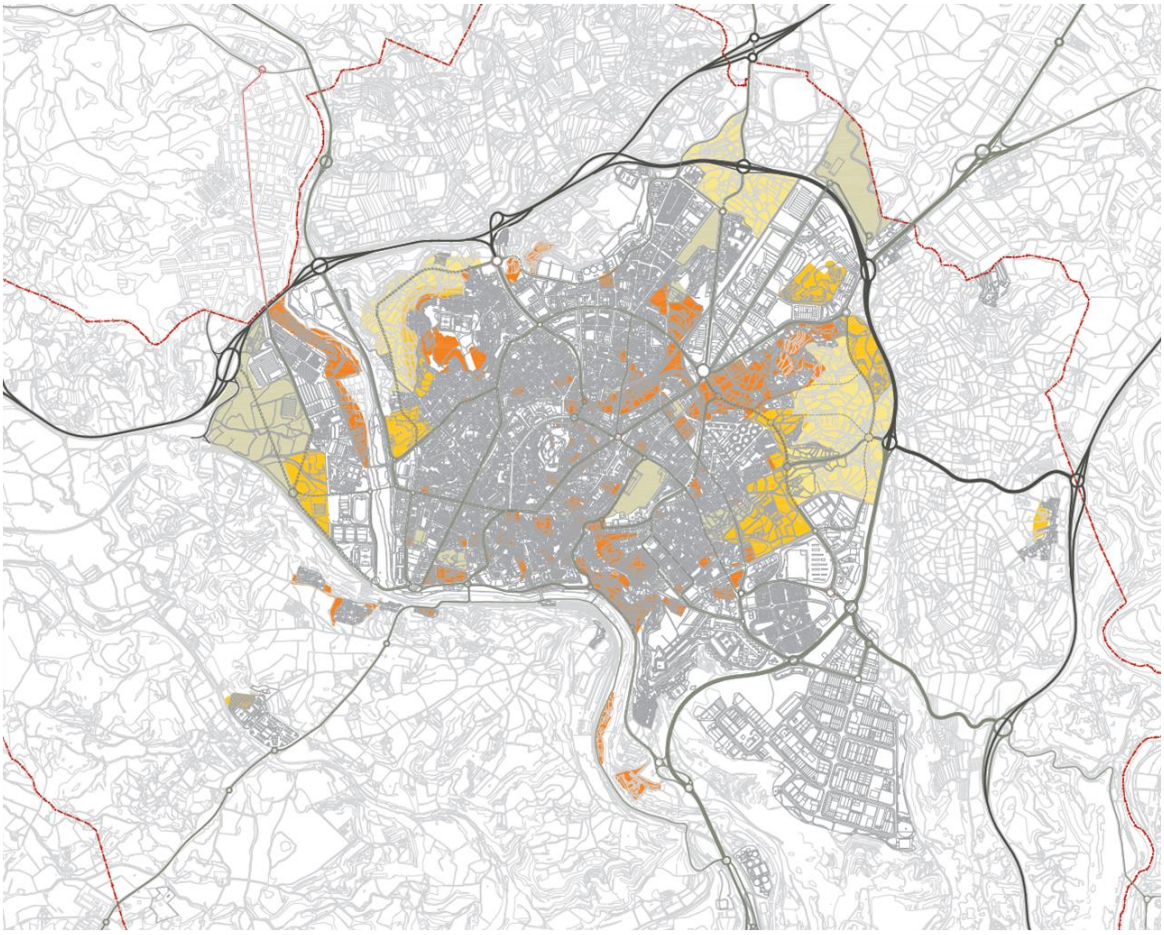

Figure 13. Blueprint image of Manresa with painted sectors to study identified so far

4.3 Key parameters relevant to CO_2 reduction

Each of the projects listed above have been studied according to the method described in chapter 2. The key parameters relevant for CO_2 reduction identified in the context of the urban development projects in Spain are described below:

Table 4: Key parameters relevant for CO_2 reductions in Spanish urban development projects

Nr.	Key parameters related to carbon reductions	Description
1	Solar exposure of projected buildings (roof / facades)	Stakeholders in the three projects agreed that different building dispositions could be made if this parameter was considered as an important one. So far, the disposition and shape of the buildings were the result of a graphic exercise of taking into account already existing urban structures, environmental conditions, interstitial space, etc. An exercise was made of drawing different options up of the final proposal, asking them to better expose the buildings. The proposals resulting from this exercise were different in all the cases.
2	Percentage of openings in facades	In Manresa there are precedents in certain areas (Old city), where proportion and size of openings are limited, due to aesthetic concerns. By, for instance, restricting the percentage of openings in north-facing facades energy heating demand will be reduced dramatically. The urban planning process, as it is defined right now, doesn't involve directives about this parameter. It could be used even at larger scales, such as the POUM revision and, if quantifiable, help in monitoring the implementation of SEAP in the city.

Nr.	Key parameters related to carbon reductions	Description
3	The characteristics of the elements of building envelope	While this is far outside of the competences of urban planners, it is also true that all European policies are leading the countries towards more efficient buildings. The envelope of buildings is one of the most important passive measures towards these high levels of efficiency. Urban planning processes could guide these efficiencies by constraining certain U-values for walls, for instance.
4	Shape of buildings	Decisions concerning the shape of the total occupied land fall directly into the scope of decisions to be made while developing urban projects. This will directly affect available roof, walls and occupied ground surface, for its use taking advantage of PV-systems, solar heating panels, geothermal energy, co-generation, and other de-centralised renewable energy sources.
5	The energy intensity for new buildings in urban area development	This parameter makes more sense in urban planning dealing with larger areas, such as some areas of the POUM revision, where no definition of the shape or position of the buildings is made. In those cases, this parameter could be very helpful in order to arrange the energy supply network related to those areas, as it simplifies calculations and provides further guidelines for more focused projects. Architects working at this scale provide quite a few parameters to manage the future development. Among these parameters, energy intensity could be included. By doing that, energy demand of large areas is defined.
6	The energy supply technology	In a future scenario where cities should comply with a certain threshold of CO_2 emissions, this parameter will end up being extremely relevant. Urban development projects could manage the energy supply by considering this among many other related parameters. It could help balancing CO_2 emissions of certain areas or neighbourhoods, etc. It is also strongly related to the final Energy Efficiency rate, and many decisions can be made within the urban Planning project, in order to decide between different energy sources feeding the buildings defined in the urban development (gas, electricity...) or going further, to arrange some space within the project to create a plant for district heating, for instance.
7	Requirements of energy supply technology	In order to decide regarding the energy supply technology, certain information about the requirements of the technology is needed (such as dimensions, ventilation requirements, technological definition of the network etc.)
8	The potential for renewable energy sources	Information regarding the possibilities of the area concerning renewable or other energy sources could be very useful to be taken into account for decision making at urban level. The solar footprint of an area or geothermal possibilities of the land are two examples of data conditioning the relevance of this parameter.
9	The Energy Efficiency Rate	Although this parameter is strongly related to all the rest, it is foreseen, in a realistic future scenario, that urban planning projects end up being the documents that guide not only the management of the land but also the energy consumption at urban scale. At urban scale, when dealing with mainly residential areas , it is foreseen this could be in the near future.

Nr.	Key parameters related to carbon reductions	Description
10	The CO_2 emissions for a given geographical urban development area	Many cities and municipalities have signed political agreements (e.g. Covenant of Mayors) where they commit to map CO_2 emissions for a base year and every second year after that. In each of the projects this parameter has been seen as a very relevant potential output to be included, for instance, as a new annex called "CO_2 impact of the urban planning project". It has been seen as a strong potential in the near future in order to help also monitor CO_2 reductions achievements in the building sector, which is something lacking in the current situation.
11	Cost-benefit analysis of a certain proposal	Economic parameters are extremely important in the current urban planning process in Spain. Actually, these parameters decide whether a new development succeeds or fails. Thus, it will be necessary to economically assess any proposal which has been made based on CO_2 related parameters, not only for calculating potential savings or costs, but also to include these values among the already used ones (construction costs, urban structure costs, sale benefits, etc.)

A total of 11 relevant parameters have been identified and included in the table above. The list includes a common description of parameters applicable for the three different selected projects. However, as the projects are slightly different (size, stakeholders, etc.), the political emphasis and relative importance has been perceived differently in each one of them. This is illustrated below (Figures 14-16).

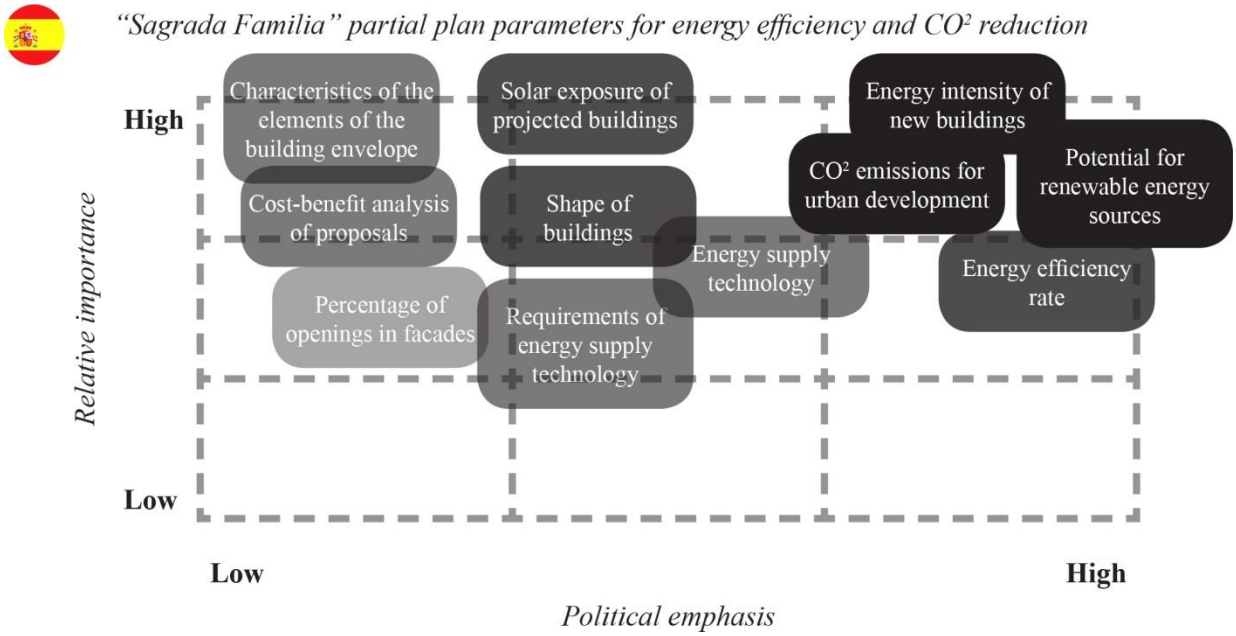

Figure 14. Relative importance & political emphasis of carbon reduction parameters for the Sagrada Familia partial plan

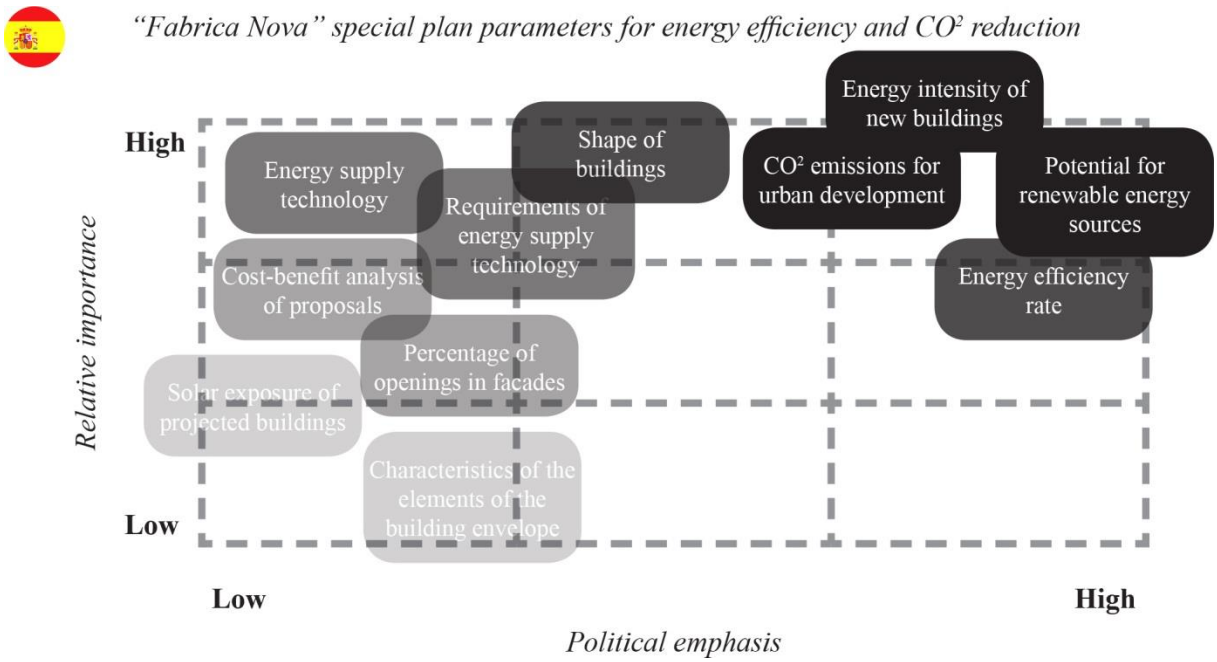

Figure 15. Relative importance & political emphasis of carbon reduction parameters for the Fàbrica Nova special plan

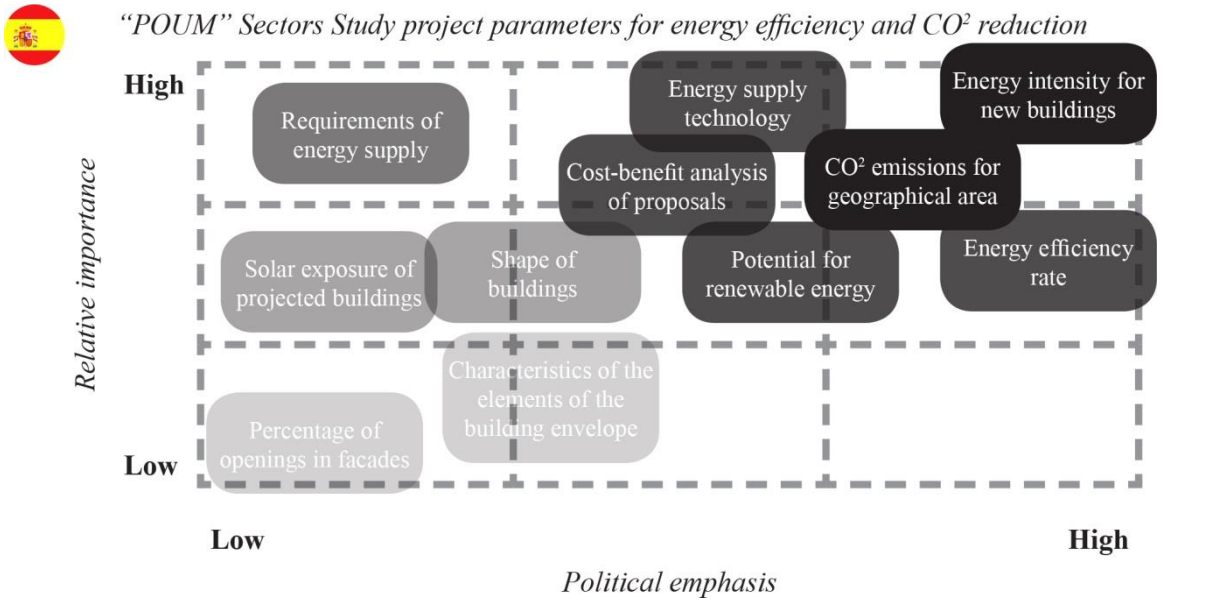

Figure 16. Relative importance & political emphasis of carbon reduction parameters for the Sectors Study

4.4 Contributions to the technological development

The following section describing the contribution to the technological platform is based on the identified key parameters and the feedback from the crib sheet interviews (cf. Appendix A2):

- Nowadays, the parameter of the cost related to a project is very important in the process of urban planning in Spain. It seems to be almost essential for assessing the viability of one or more options. It was noticed during the three interviews that this issue was raised spontaneously during conversations. Therefore, including the cost parameter in the analysis carried out using the tools developed to guide the decision making process is extremely relevant.
- When working with large urban areas sometimes decisions are made affecting wide landscapes (like in the case of some of the decisions made during the POUM revision). At

this scale of work, introducing information at building level might become useless, as there is little level of detail and not very concrete. In these situations, the users of the technological platform may be able to identify energy intensities for large areas of urban development rather than identifying the exact building parameters. Options allowing this sort of information could be very useful in the technological platform.

- Since shadows affection has been seen as one of the most important parameters to be considered in the Spanish case when deciding between different urban structure options (it affects not only sun exposure but percentage of windows in facades and potential sun-depending energy systems), it has become important that the tool developed allows the user to easily interact with shapes of different building typologies, meaning rotation, movement, extrusion, etc. all within a nicely usable 3D environment.
- In most of the policies requirements addressed in the studied urban development projects, the CO_2 emission parameters identified seem to be the most transversal parameters, which could be used to compare with other policy requirements in other urban development projects. CO_2 related parameters will allow a comparison of the effect of CO_2 emission reduction policies (e.g. energy efficient urban lightning, mobility management etc.) across different urban development projects. It seems that this is one of the most important parameters which should be highlighted in a final report developed by the technological platform when the user has carried out an analysis using the tools developed.

5 REQUIREMENTS CAPTURE IN UK

5.1 Introduction

Within the UK there are a multitude of possible planning and regeneration projects dealing with diverse and complex challenges in the delivery of sustainable development. There is currently a statutory emphasis and presumption in favour of delivering sustainable development projects as set out in the National Planning Policy Framework. This emphasis on 'delivery' has recently been imposed following the change in government after the 2010 general election and the considerable impacts on projects from the global recession.

The scale of many projects and the corresponding timescale has meant that often objectives -in the form of key performance indicators and parameters- have changed political emphasis and, in some cases, been changed completely as national and local politics have changed. In selecting the four case studies, we have had regard to projects at different stages of delivery and noted the growing significance of financial viability alongside technical feasibility of sustainability requirements.

5.2 Brief descriptions of urban development projects

The urban development projects considered in the UK case were selected pragmatically on the basis of access to material and individuals with direct involvement in each of the projects. They are typical of the challenges of regeneration in many of England's northern conurbations with complex mix of stakeholders, funding and socio-economic concerns in addition to the physical and technical concerns around the delivery of sustainable urban communities.

The urban development projects have been listed below:

- Middlehaven, Middlesbrough – Large brownfield riverside development using sustainability as a means of rebranding and dealing with image and stigma
- Hulme, Manchester – Pioneering approach to the regeneration of a sustainable urban community
- Leicester Square Mile – A coordinated partnership approach to larger scale sustainable refurbishment
- Gateshead BIG – Competitive and collaborative area-based regeneration partnership

Brief project descriptions are given below.

Middlehaven, Middlesbrough

The regeneration of Middlehaven Docks in Middlesbrough was one of the first examples of design and sustainability-led re-branding of places in the UK (Figures 17-19). Two separate aspects of regeneration were required to deal with the underlying stigma of the area, and the project included a mix of proposals for housing demolition / clearance and new build. The site north of the railway line and south of the river Tees was cleared for 'transformational new development' aimed at attracting new residents to the town. This was given Council approval in 2005 and promoted through the production of a strategic regeneration framework; commissioned by the local municipality in partnership with the regional development agency[3]. Within this strategic regeneration framework was the use of the phrase 'Big Architecture'

[3] An approved framework / master plan that has been adopted by the local authority for guiding new development is the minimum requirement to allow the municipality to use their statutory powers of compulsory purchase

(Porter, 2011) to describe design-led regeneration and area-based re-branding, as a response to area-wide stigma within Middlehaven. However more cynical stakeholders, described this as 'Blairville' (Shippey, 2007; Shippey, 2005) and questioned the wider ethical issues about the institutional and political bias towards large property developers.

Figure 17. Greater Middlehaven, phase 1 (Image by Alsop Architects / Quintain Bioregional) and UK national press article on the collapse of the Quintain Bioregional proposals in 2009

This approach to development was reviewed in 2009 in the light of the impact the recession was having on national and local house building, particularly the collapse of the developer Bioregional Quintain during the first phase of the Middlehaven scheme. Out of this review emerged a revised master plan (Urban Initiatives, 2012) seeking to test ideas of large-scale custom building as an alternative form of development.

At this stage, the later phases of the redevelopment of Middlehaven are ongoing and retain the emphasis on sustainability and One Planet Living / ecological foot-printing.

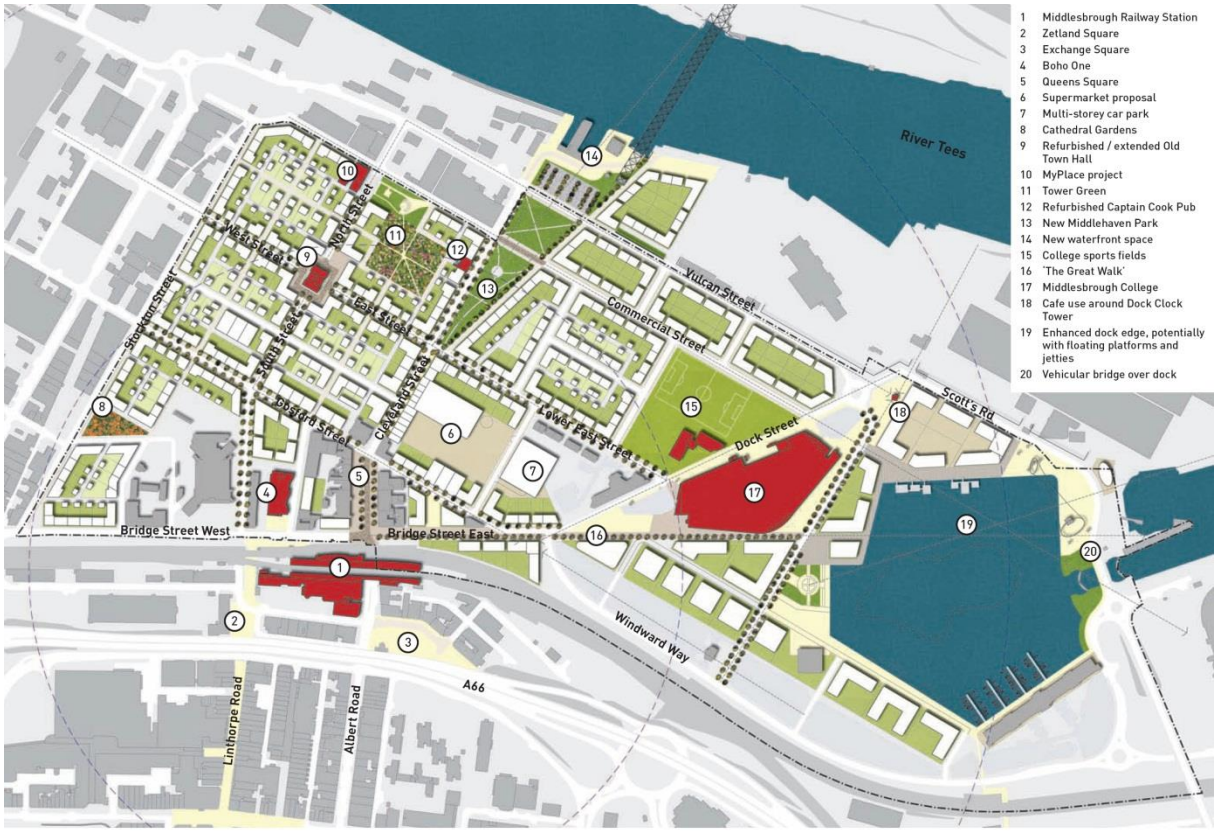

Figure 18. Middlehaven Urban Pioneers proposals. Image by Urban Initiatives (2011)

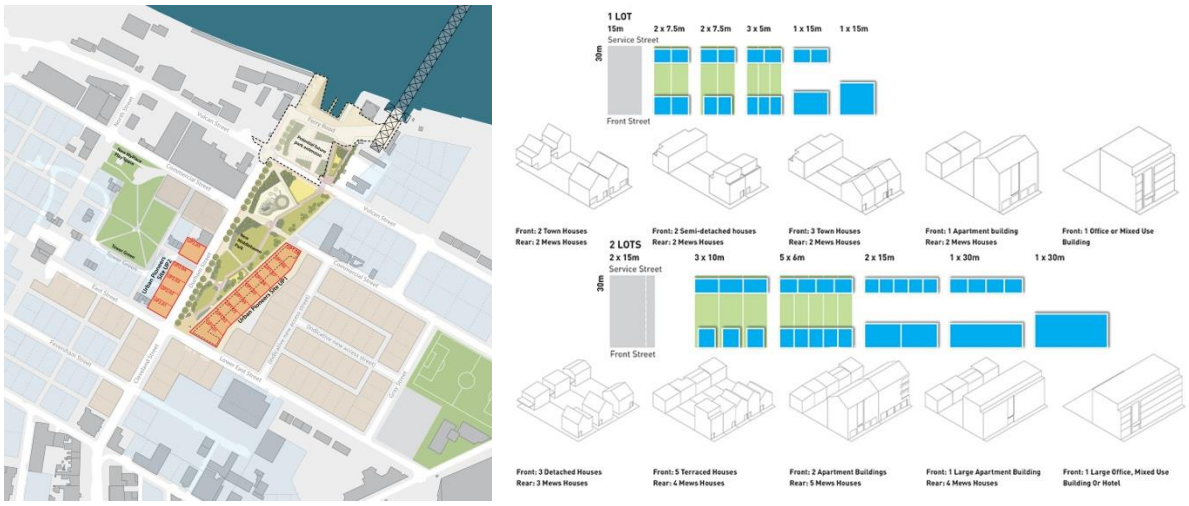

Figure 19. Initial Middlehaven Urban Pioneers plots for the second phase of delivery of custom-build homes. Design and sustainability guidance provided by a statutory urban design code. Images by Urban Initiatives

Hulme, Manchester - Pioneering approach to the regeneration of a sustainable urban community

The current major redevelopment of Hulme has resulted in one of the most advanced approaches to sustainable inner-city regeneration in the UK (Figure 20). The area is about one mile from Manchester city centre. In the 1960s, the area was the subject of comprehensive clearances and high rise redevelopment, including the infamous deck Hulme crescent blocks. In 1991, the then Environment Secretary, Michael Heseltine, approved a financial package to regenerate Hulme as part of the City Challenge initiative. Manchester City Council won a grant of £37million to replace existing housing - apportioned between the North British Housing Association, The Guinness Trust, and private developers, who built new properties. The council-funded tenants' association, the Hulme Tenant Participation Project, pressed the case for the development work to be phased, eliminating the need for large-scale re-housing, and balancing the physical change with stability, whilst building on the experience gained in each phase.

The 'action plan' that emerged from this policy framework accepted many of the previous failures of government intervention. It also recognised the vision for the area will need to "... have strategic significance for the City as a whole" ... "the area being integrated within the City both physically, through the road and transport infrastructure, and psychologically for those who live or work in the area" (Hulme Regeneration, 1992). The balance that the regeneration partnership was seeking was primarily physical and design-led, bringing back traditional urbanism in a package of integrated design that includes investment in education, transport, infrastructure and local economic development. However this time it was through a more participative and inclusive way, where the management of the process was more sensitive to the local context, both people and places.

Hulme was one of the first mainstream projects to use 'Planning for Real' techniques, an intense period of work with all stakeholders being involved and assisted by an independent facilitator (Whitehouse, 1996) with the aim of consensus over the strategic options for regeneration. These began as a set of strategic elements such as principal public spaces for congregation set against some of the existing community buildings, reinstatement of routes to reconnect the area with neighbouring communities and the city centre. The strategic vision also defined local landmarks, developed strategic links and explored socio-economic issues wherever they had spatial considerations or impinged upon physical design. Procedural and phasing concerns did include consideration of the wider context, particularly the creation of a positive image for Hulme, as much as to retain existing businesses as attracting new investment. It also examined

ways of retaining community links and coping with the prospects of "living on a building site" (Hunt Thompson Associates, 1992, p53) as one of the critical success factors is to retain residents as much as attract newcomers to the area and the city. Urban design and sustainability guidance took the form of a master plan and design code both reliant on traditional housing forms becoming integrated into a mixed-use development. The design code was produced in partnership as a collaborative guide by professionals and public (Ross, 1997) and set out the shared values for the redevelopment for traditional urbanism, environmental quality and sustainability.

Figure 20. Hulme 'Concept Plan' (Image AMEC) and aerials from 1990, prior to redevelopment and 2011 showing long-term changes

The development has pioneered several significant proof-of-concept approaches to sustainable urbanism and autonomy (Rudlin & Dodd, 1998) at a variety of scales from an individual construction project to the city-region. Most significantly the project attempted to demonstrate whole life costing and the viability of sustainable communities, linking costs with emissions in long-term business planning. There is a strong physical legacy in many local developments, such as the 'Homes for Change' housing cooperative as one of the first exemplars of sustainable housing (Rudlin, 1996; Carter 1996 & Fauset, 2000) in the UK. A ten year evaluation of the redevelopment found very positive effects in urban regeneration and over 80% of the regeneration objectives of the original plan have been realised (SURF, 2002) and that there was growing pressure, to be resisted, for moving away from a stable and family-friendly area towards one that provides for a more cosmopolitan and transient population that has become more typical of other successful inner city regeneration areas. New urbanism in Hulme demonstrated the importance of processes in the creation of sustainable communities together with the physical design principles. As the impetus for change in many other English cities, particularly issues of disenfranchisement, disempowerment and social stigma, were the same as in Hulme.

Leicester Square Mile – A coordinated partnership approach to larger scale sustainable refurbishment

The Square Mile project is a strategic partnership between Leicester City Council, the two local universities and a number of large social housing providers in the City (Figure 21). The aim is to look at the potential for cost-effective and practical large scale property refurbishment and reduction in carbon emissions, using knowledge transfer from the universities around a mix of technical and financial knowledge.

A number of pilot areas, including one significant area immediately south of the city centre, have been identified as areas to test the practical delivery of energy efficiency improvements at scale. This has been the basis for undertaking detailed stock assessment (mixed housing and commercial properties) using bespoke project software that is underpinned by an up-to-date cost database for an extensive range of energy efficiency improvements and property refurbishment. This information has been supplemented by local data on fuel poverty, the actual costs of energy bills together with real SAP figures for the properties. The partnership is

currently developing a series of locality-specific retrofit packages (physical proposals, management changes and financial products) in a format similar to the national Green Deal programme.

Figure 21. Leicester Square Mile project area south of Leicester City Centre

Gateshead BIG – Competitive and collaborative area-based regeneration partnership

Gateshead Council is based in the north east of England on the south banks of the river Tyne next to Newcastle and forms part to the Tyne and Wear urban conurbation (Figure 22). Gateshead Council has brought together a collection of public sector development sites (a mix of existing ownership and strategic land assembly) within the municipality into a single partnership opportunity for long-term delivery of sustainable communities within the town. It is a 'package' approach that was presented as the 'BIG Opportunity' for Gateshead. It is estimated at a total value of €425million (£347million) over a fifteen year build period, making it one of the largest development agreements within the UK. Gateshead Council is partnering with private developers and social housing providers as a newly-formed public / private partnership called 'Evolution Gateshead'. This new special purpose vehicle will be responsible for approximately 2,500 new homes and associated public spaces and community facilities. The underlying political intention has been the creation of exemplary sustainable communities. These are intended to be complementary in the choice of design and sustainability to the existing housing market and that helps to continue the wider regeneration of the housing market in Newcastle Gateshead.

Figure 22. Plan and perspective of Freightliner site Gateshead, one of 19 strategic sites included within the Gateshead BIG competition. Image by Studio EgretWest (2011) Architects and Master planners.

5.3 Key parameters relevant to CO_2 reduction

Each of the projects listed above have been studied according to the method described in chapter 2. The key parameters relevant for CO_2 reduction identified in the context of the urban development projects in UK are described below:

- Middlehaven, Middlesbrough – Large brownfield riverside development using sustainability as a means of rebranding and dealing with image and stigma

Table 5. Key parameters relevant for CO_2 reductions in the Middlehaven, Middlesbrough urban development project

No	Key parameters relating to carbon reduction	Description
1	Household resource consumption	Holistic set of data measures covering energy usage plus indicators for food, waste, water, transport and other qualitative measures. Household data as primary measure to allow for regional and national comparisons.
2	Incremental energy loading	The economic slow-down has created a significantly different timescale for development. Phasing has become less certain and site experience has demonstrated that provision of community-scale district heating can be impractical and unviable in such a scenario.
3	Security of energy supply	Delays and phasing has meant that commissioners are becoming less risk-adverse around any

No	Key parameters relating to carbon reduction	Description
		significant energy infrastructure that is dependent upon certain quantum of development. There are also worries around projecting renewable fuel (in this instance biomass) costs to a longer timescale that initially anticipated.
4	Building occupancy rates	Alternative scenarios for significantly reduced occupancy rates for both business and residential uses. These impacts on the viability for individual building systems and in the case of larger mixed use properties.
5	Morphology, orientation and layout	Early design stage consideration over the form and shape of the later master plan phases. There has been some expressed concern that without some form of initial assessment, many of the plots (particularly the east-west facing plots) and routes will be unsuitable for higher Code for Sustainable Homes levels and / or Passiv Haus standards. This is a recent and growing concern where the impact of optimisation for orientation for passive solar gain has increased weight in high-performance buildings.
6	Building geometry and relative heat-loss	Consideration of how the collective impacts of heat loss parameters for individual buildings and properties impact on the building geometry. This is something that has been passed over in consideration at the master planning / design stages.
7	Individual building energy performance	Social housing providers have an interest in properties suitable for affordable housing that can be developed to minimum Code for Sustainable Homes level 4 and Fabric Energy Efficiency standards.
8	Floor space Gross to Net ratio	Specific to multi-occupancy and mixed use buildings. There is a financial imperative against having heating and other management revenue costs for shared or communal areas. This is increasingly seen as a waste and poor business particularly around the role of the social housing providers and the need to ensure affordable and competitive rents.
9	Property tenure	Knowledge of property ownership is a prerequisite for targeting refurbishment through the 'facelift programme' for the town's older housing stock. There is also policy significance in meeting local affordable housing needs through social housing and low–cost home ownership products.
10	Number of property clearances	National measure as part of the Housing Market Renewal Pathfinder programme. It was also considered as an important factor in comprehensive regeneration and the attraction of new sustainable development.
11	Building for Life Assessment	Building for Life is a series of 20 principles, intended for use early on in design development of residential developments as a design tool to help create sustainable development and improve the quality of housing across the UK. The application

No	Key parameters relating to carbon reduction	Description
		is supported by a supplementary planning document on urban design quality and energy efficiency and with pre-application advice from Council officers.
12	Decent Homes	Similar social housing standard applied to rates within private landlord / renting sector.
13	Energy efficiency measures	There is a commitment to "work with the private sector and other housing providers at pre-application stage to deliver well designed and energy efficient housing." (Middlesbrough Council 2008, Priority Action 6). This is assessed through the number of properties benefiting from energy efficiency interventions, including a 'package' approach to new / additional insulation and efficient boilers. Affordable Warmth Area-based funding through *Warm Front* that targets vulnerable households to provide affordable warmth.
14	Lifetime CO_2 savings	Tonnes of carbon saved through energy efficiency measures and training (provided in Middlehaven by *Go Warm*). An explicit indicator within the Council's *Affordable Warmth Strategy*.

- Hulme, Manchester – Pioneering approach to the regeneration of a sustainable urban community

Table 6. Key parameters relevant for CO_2 reductions in the Hulme, Manchester urban development project

No	Key parameters relating to carbon reduction	Description
1	Population (occupancy levels) and housing densities	Measured as persons per hectare (pph) and gross number of dwellings per hectare (dph). Metric was formerly used for planning and plan monitoring and was also used to assess overall development capacity and corresponding levels of service, including energy demand.
2	Land dereliction / property void levels	Interest in underutilised assets of land and buildings. Used to inform potential additional capacity for new build and / or reuse.
3	Property tenure	Supporting information in targeting social housing as a priority. Additional support in targeting larger blocks / areas of single ownership (typically private landlords) and for land assembly strategy.
4	Space and water heating demand	Measurement of area-based heat demand to inform decisions for community heating or wider urban connections to heat networks.
5	Power demand for lights and appliances	Electricity demand to be met by solar PV or biomass fuelled CHP. Alternatively to be used for reduction of demand through area-wide energy efficiency initiatives targeted at electricity

No	Key parameters relating to carbon reduction	Description
6	Water supply and demand profile	Measurements necessary for collection and storage facilities when water is used as a heat storage medium, hydro generation or as a condensed or purified supply for CHP.
7	Level of organic & compostable waste	Potential input for anaerobic digestion for the human and household organic waste stream. Including food & organic waste from schools and hospitals.
8	Transportation emissions	Car usage within high density urban environment linked to public transportation planning (including zero emission / renewable fuels), cycling and walking options.
9	Whole life costing	Combination of capital and revenue costs for energy efficiency measures and potential savings.

- Leicester Square Mile – A coordinated partnership approach to larger scale sustainable refurbishment

Table 7: Key parameters relevant for CO_2 reductions in the Leicester Square Mile urban development project

No	Key parameters relating to carbon reduction	Description
1	Percentage of households living in 'decent housing'	'Decent housing' is a central government definition relating to the expected improvements made to public sector and social housing. It has been the most significant intervention programme in recent years that has resulted in incremental retrofitting for energy efficiency. Data is available from the English Housing Condition Survey (UK Government 2010).
2	Fuel poverty	Number of households spending >10% of income on fuel. This definition has recently been subject to changes at a national level. It supports regional and national comparisons using a mix of national government indicators.
3	Total household energy expenditure	A relative measure that informs advice on choice of supplier / tariff and as an input in any national or local Green Deal assessment relating to pay-back periods for any significant investment into property energy efficiency.
4	Energy Performance Certificate Rating	EPCs as issued as a legal requirement for the sale / renting of domestic property. Calculations are made using a validated *f*SAP or *Rd*SAP (Reduced data standard assessment procedure) software package.
5	Property age	The age of the dwelling can be used to determine the typical construction type and fabric efficiency levels (u values). This is accepted as an approximation based on a series of age ranges that relate to the prevailing changes in building regulations that were being enforced at the time of construction. Limited accuracy when used to assess hybrid construction techniques

No	Key parameters relating to carbon reduction	Description
6	Number of occupants	Census information used for normalisation of data.
7	ECO uptake	Energy Company Obligation requirements for the 'big six' energy providers to reduce CO_2 emissions through targeting fuel poor and / or vulnerable households and inefficient properties.
8	Green Deal uptake	Number of dwellings undertaking comprehensive energy efficiency measures to the property fabric and building services with Green Deal loan or similar. Green Deal loans are 'pay to save' investments that remain with the property rather than the owner. Typically require a 'golden rule' test to illustrate effective pay-back periods of less than 7 years.

- Gateshead BIG – Competitive and collaborative area-based regeneration partnership

Table 8: Key parameters relevant for CO_2 reductions in the Gateshead BIG urban development project

No	Key parameters relating to carbon reduction	Description
1	Area-based heat loading	The area-based approach and potential for the provision of community-scale heat (mix of space heating and hot water) that could be considered an 'allowable solution' under the definitions within the Code for Sustainable Homes. Potential for provision through local ESCo. Specific interest in the provision of a viable biomass district heating boiler or a gas fired Combined Heat and Power Plant (CHP) as the first phase of a local / group heating network. Detailed understanding around the appropriate sizing of a CHP plant. Part of the consideration is the identification of a reliable (and where possible local) renewable fuel supply. As an additional consideration, to allow for both biomass and fossil fuels.
2	Building fabric energy efficiency	At a design stage and making technical specification, there is a trade-off between good levels of air tightness and the levels of thermal mass and retaining heat. This has a significant effect on the strategic choices of construction methods and systems, particularly where non-traditional 'modern methods of construction are being considered.
3	Dwelling Emission Rate / Target Emission Rate[4]	This is a measurement of the relative improvement of the dwelling (recorded as the dwelling emission rate) over the mandated requirements within statutory building regulations or those imposed through funding requirements recorded as the target

4 This Target Emission Rate (TER) is the minimum energy performance requirement for new development measured as the mass of CO2 kg/m2 per annum, combining emissions from space heating, hot water, ventilation and fixed lighting. It is consistent with Regulation 17B of the Building Regulations 2000. The figures and methodologies directly relate to the mandatory requirements for minimum percentage reduction in the Dwelling Emission Rate over the Target Emission Rate as set out within Part L1A of the Building Regulations and the Code for Sustainable Homes.

No	Key parameters relating to carbon reduction	Description
		emission rate. It can be extracted from SAP calculations and considered in scaling calculations through the use of property typologies. This is calculated as primary energy demand measured at kWh[m^2a] combining requirements for space heating, hot water and electrical load, to provide a consistency in calculations against policy requirements.
4	Percentage of on-site / near-site Low or Zero Carbon (UK Green Building Council 2008) energy provision	A reflection of national policy and the intention to encourage the earliest consideration of energy and carbon reduction in the design process improvements to the specification and performance of the building fabric in order to ensure meeting a minimum level of renewable energy provision is viable. Percentage is of primary energy demand. Policy targets relate to the relative scale of development and how this impacts on scheme viability (Entec, 2010).
5	Development site capacity	Measurement of the realistic development potential capacity of each of the individual development sites. This is a mix of notional capacity (based on site area multiplied by typical gross density) and design-led capacity, based on the current BIG development proposals. These figures are regularly updated for the municipality as part of the statutory Strategic Housing Land Availability Assessment (Gateshead Council 2013).
6	Net carbon saving from renewable energy	Interest in policy to support contributions to a Community Energy Fund as exception or means of achieving on-site or near-site Low / Zero Carbon energy provision. Contributions should fund expansion, connection or new provision of a community heat network of equal or greater net carbon saving.
7	Energy plant lifetime carbon savings	There is an explicit requirement for the operator of any communal energy plant to assess the estimated lifetime carbon savings of the design proposals. This requires the anticipated design life of the infrastructure and any other capital investment set against projected reduction in CO_2 emissions. This has been identified as a mandatory requirement to access areas of grant support such as CO_2 Saving Agreement through CESP funding.
8	Renewable Heating Incentive tariff	This is linked to information used to assess the viability of district heating, supporting the viability and preliminary business planning for a CHP network. There are requirements for flexibility and simplicity in the system design to support phased expansion that can consider the cost of piping network and associated infrastructure for a heat network.
9	Predicted electricity export tariff	As above, this parameter relates to the business planning for CHP (scaling and phasing) network.

No	Key parameters relating to carbon reduction	Description
10	Domestic energy usage	Actual (a.k.a. monitored) energy usage to support ongoing energy supply and targeting mix of physical and procedural / fiscal interventions.

A total of 41 relevant parameters have been identified and included for the UK development projects in the tables above. The tables include descriptions of the parameters applicable for the four selected projects. The political emphasis and relative importance of the parameters identified have been illustrated below (Figures 23-26).

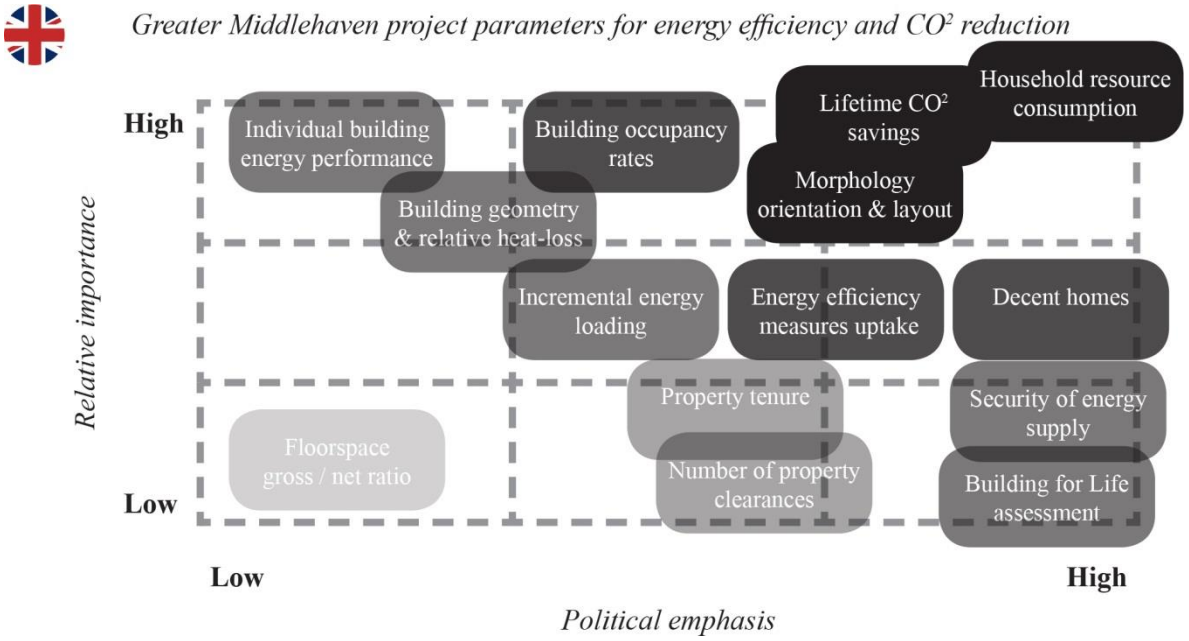

Figure 23. Relative importance & political emphasis of carbon reduction parameters for the Greater Middlehaven Master plan, Middlesbrough.

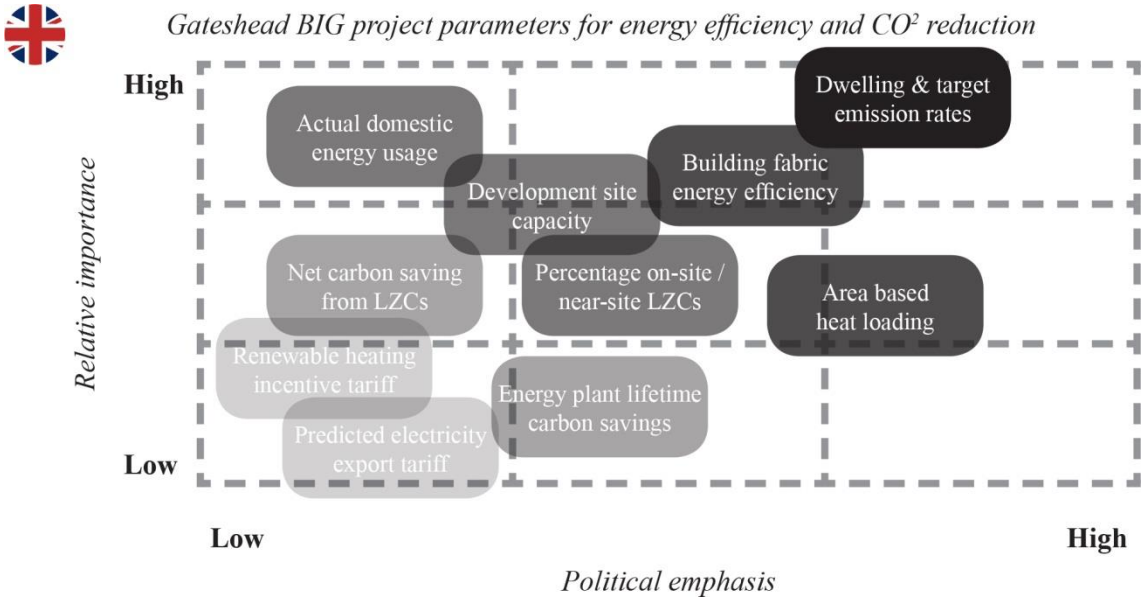

Figure 24. Relative importance & political emphasis of carbon reduction parameters for the Gateshead BIG regeneration project.

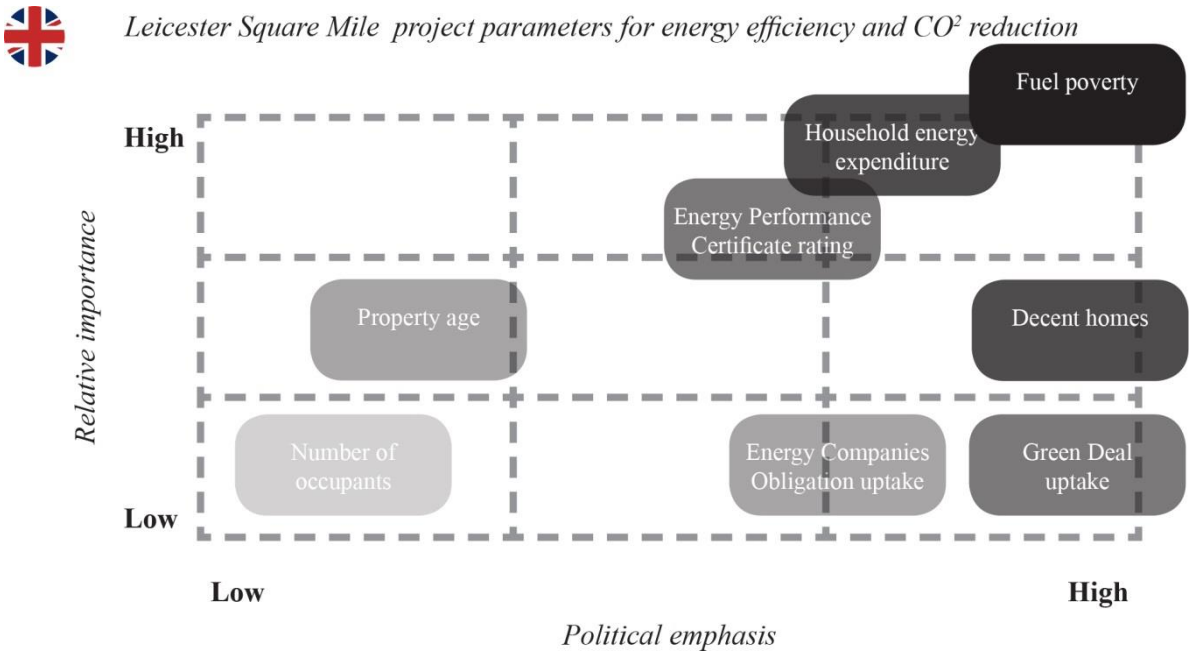

Figure 25. Relative importance & political emphasis of carbon reduction parameters for the Leicester Square Mile retrofitting project.

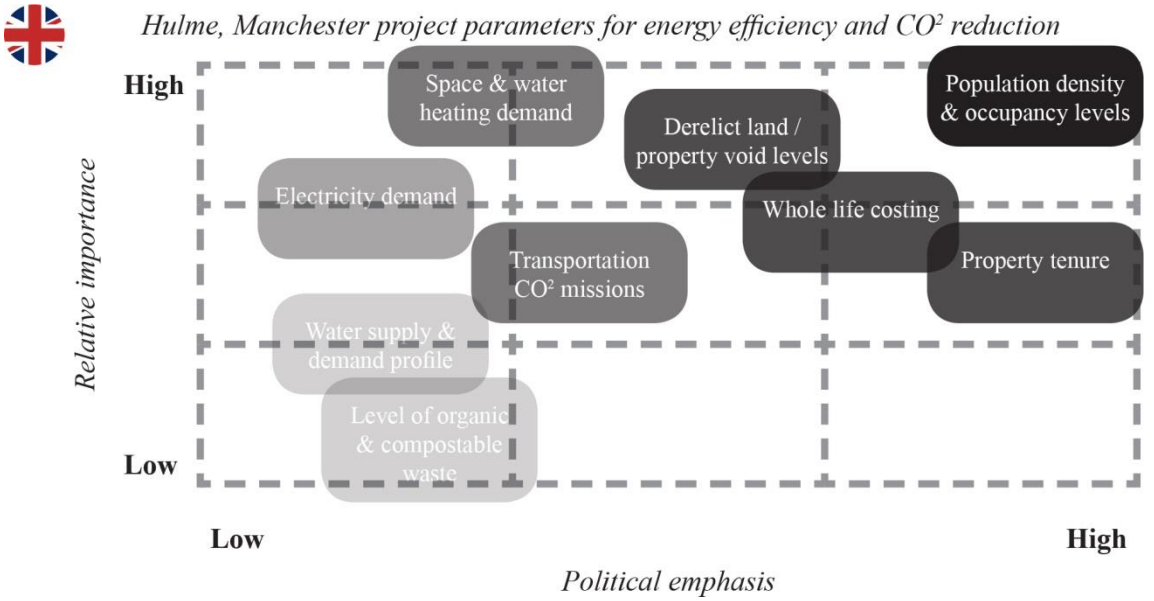

Figure 26. Relative importance & political emphasis of carbon reduction parameters for Hulme, Manchester.

5.4 Contribution to the technological development

The spatial and temporal scale of certain larger regeneration projects in the UK combined with the procedural complexity around the stakeholder and political requirements demonstrates a diversity of parameters and indicators. With the exception of a small number of Core National Indicators on Carbon Emissions, most of the parameters are being defined and used at a local project-specific scale and with the specific requirements of the individual stakeholders. Yet there is some potential contribution to the technological development of the SEMANCO platform if these parameters are considered in thematic groups. The common 'groups of parameters' are derived from the emphasis that the public sector and agencies have in the leadership and management of most planning and regeneration projects.

There is a clear group of parameters that are based on the physical geometry of the site and / or developments. There is significance in the geometry at a variety of differing scales in the assessment of carbon emissions and the calculation of energy demands in the UK context. Many of these parameters are underpinned by measurements of development site quantum and building geometry, be it numerical densities, gross floor areas that are commonly used and referred to within the National Planning Policy Framework. Site areas (both gross and net 'developable' areas that exclude strategic infrastructure such as roads and green spaces) can be linked to typical density assumptions for a variety of different scales that would require the inclusion of evidence / case record assumed densities for dwellings and floor space in square meters per hectare. Often these basic density assumptions are included in planning policy as a minimum and / or typical range that results in an overall development capacity for the project. Simple and small adaptations to the calculations within the model could usefully begin to provide some of the higher level parameters needed for this sort of planning and monitoring at neighbourhood and / or city scale. Small additions to the parameters displayed and presented would have potential benefit for simple statutory plan monitoring and the assessment of developments, including many of the parameters for area-wide heat demands and on or near-site provision of low / zero carbon technologies.

The following section describing the contribution to the technological platform is based on the identified key parameters and the feedback from the crib sheet interviews (cf. Appendix A3):

- For new development, refurbishment and the more normal hybrid mix of both, there is the prevailing importance of values and costs. These have become more important in the current recession and the period of recovery that is currently occurring within the UK construction industry. In most cases these are largely cost ranges and / or estimates based on quantity surveyor consultant calculations using the building geometry and dimensions as one of the significant input requirements. There would be a clear additional functionality if it were possible to integrate costs (construction / refurbishment) into the platform, albeit this would be necessarily crude due to the actual availability and commercial sensitivity of accurate costs. While some large commercial databases on new building and refurbishment costs are available, there would be additional functionality within the technological platform if the relative cost impacts were able to be calculated. There is a tacit acceptance with most stakeholders that high accuracy and up-to-date figures would be valuable but costly. Within early project stages; such as business justification, planning and outline design stages; relative costs and approximate values would still have the necessary benefits in supporting decision-making.
- Many of the procedural concerns around a mix of formal statutory planning and informal community involvements would benefit from better visualisation and communication of the data. This is particularly important where there are aspects of 'image' and 'branding' integral to the project and where (in theory if not in commercial practice) the sustainability performance of the proposals is intended to play a part in the USP of the project. In this context, the differentiation of the development against neighbouring developments and areas would be one of the most valuable benefits of visualisation of the relative energy demands, carbon emissions and similar. The provision of choice between 2D and 3D visualisation may aid the appropriate representation of different scales of socio-economic data sets.
- Lifestyle parameters that impact on household and area-wide CO_2 emissions perhaps present some of the most significant challenges for the development of the SEMANCO platform. Behavioural concerns such as travel, food, water, embodied energy and the consumption of other limited resources seem to have a similar weighting in decision-making as the emissions from the built environment in use. There is some potential for the use of proxy or default measures around typical patterns of resource consumption at

the household level. These tend to vary against household income and expenditure levels. Hence, the potential for the SEMANCO platform to extend the typical household income levels to make these sort of 'ecological foot printing' calculations could be considered where stakeholders have a particular interest in a more holistic approach to reporting overall resource consumption and carbon emissions.

6 SUMMARY OF THE REQUIREMENTS CAPTURE

6.1 Introduction

This chapter focuses on summarising the key parameters relevant to CO_2 reductions in the urban development projects studied in the three case study countries (e.g. Denmark, Spain, and UK). It also presents a summary of the contribution to the technological development in the SEMANCO project based on the identified key parameters and the feedback from the crib sheet interviews capturing the policy, data, stakeholder and technological requirements in the urban development projects which are the object of this study.

6.2 Key parameters relevant to CO_2 reductions

The case study country partners have been able to identify key parameters relevant to CO_2 reductions in a total of 11 urban development projects. In the cases of Denmark and Spain a common set of parameters on a country basis have been identified whereas is the case of the UK the key parameters are individual for the specific projects.

In the case of the three projects considered in Denmark, the key parameters reflect the Danish understanding of sustainability related to energy consumption in urban development projects, which has been used in the energy analysis conducted for the clients in the four urban development projects.

In the Spanish case, the goal has been to identify those parameters which were conditioned in the decision making process from the beginning, and which CO_2 related parameters were either considered or missing during the process in three urban development projects.

For the UK case, the underlying economics and business case for the individual projects remained the most significant factor and resulted in a wider range of parameters with little overlaps between the four urban development projects.

The findings are summarised in the tables below.

Table 9. Summary of urban development projects, key parameters relevant to CO_2 reductions

Urban development projects in Denmark, Spain and UK	**Key parameters identified relevant to CO_2 reduction in urban development projects**
Denmark	
• Vinge and Copenhagen Cleantech Park, Municipality of Frederikssund • Køge Coast, Sustainable Urban Development • Fredericia C, the Amsterdam of Jutland • Risø Park - development of a Science Park at DTU Risø Campus	• The energy intensity for new buildings in urban area development • Performance specifications for energy consumption in the buildings, such as specifications for Energy Class Energy producing buildings • The energy supply technology (e.g. building level, neighbourhood level, district level) • Form and orientation of buildings • The characteristics of the buildings fabric (e.g. U-values of walls, roofs, basement, windows, doors, percentage of glass, losses etc.) • The number and type of electrical appliances (e.g. refrigerator, stove, TV, computers etc.) and systems (e.g. ventilation, lighting, pumps etc.) for a standard house or office • The consumer energy consumption behaviour • The dimensions (e.g. capacities, size, volume etc.) and energy supply technologies and components • The land use for energy supply technologies and components • The potential for renewable energy sources • The CO_2 emissions for a given heat production technology • The CO_2 emissions for a given geographical urban development area • The energy consumption and CO_2 emissions in a baseline scenario • The effects of different CO_2 reducing measures in a scenario • Consumer energy price for heating and electricity • Socio-economic costs for energy supply solution • Municipal costs for chosen energy solutions and options
Spain	
• Sagrada Familia Partial Plan • Fàbrica Nova Especial Plan • Sector Study work within the context of the Urban Master Plan of Manresa revision.	• Solar exposure of projected buildings (roof / facades) • Percentage of openings in facades • The characteristics of the elements of building envelope • Shape of buildings • The energy intensity for new buildings in urban area development • The energy supply technology • Requirements of energy supply technology • The potential for renewable energy sources • The Energy Efficiency Rate • The CO_2 emissions for a given geographical urban development area • Cost-benefit analysis of a certain proposal

Urban development projects in Denmark, Spain and UK	**Key parameters identified relevant to CO_2 reduction in urban development projects**
UK	
• Middlehaven, Middlesbrough –	• Household resource consumption • Incremental energy loading • Security of energy supply • Building occupancy rates • Morphology, orientation and layout • Building geometry and relative heat-loss • Individual building energy performance • Floor space Gross to Net ratio • Property tenure • Number of property clearances • Building for Life Assessment • Decent Homes • Energy efficiency measures • Lifetime CO_2 savings
• Hulme, Manchester	• Population (occupancy levels) and housing densities • Land dereliction / property void levels • Property tenure • Space and water heating demand • Power demand for lights and appliances • Water supply and demand profile • Level of organic & compostable waste • Transportation emissions • Whole life costing
• Leicester Square Mile	• Percentage of households living in ‘decent housing’ • Fuel poverty • Total household energy expenditure • Energy Performance Certificate Rating • Property age • Number of occupants • ECO uptake • Green Deal uptake
• Gateshead BIG	• Area based heat loading • Building fabric energy efficiency • Dwelling Emission Rate / Target Emission Rate • Percentage of on-site / near-site Low or Zero Carbon (UK Green Building Council 2008) energy provision • Development site capacity • Net carbon saving from renewable energy • Energy plant lifetime carbon savings • Renewable Heating Incentive tariff • Predicted electricity export tariff • Domestic energy usage

6.3 Contribution to the technological development

The ultimate purpose of the requirements capture process which has been conducted in relationship to the 11 projects described in the previous chapters is to verify whether the current prototype of the SEMANCO platform could provide any added value to new urban development projects and, also, to suggest additional functionalities which can be implemented to the platform in its subsequent developments.

The findings based on the identified key parameters and the feedback from the crib sheet interviews are summarised in the table below.

Table 10. Summary of urban development projects and contributions to the technological platform

Urban development projects in Denmark, Spain and UK	**Contributions to the technological platform**
Denmark	
• Vinge and Copenhagen Cleantech Park, Municipality of Frederikssund • Køge Coast, Sustainable Urban Development • Fredericia C, the Amsterdam of Jutland • Risø Park - development of a Science Park at DTU Risø Campus	• The 3D model visualisation functionality would have added great value to the project in the planning/competition phase as well and could have been used to model and visualise energy demand and energy supply for the city/neighbourhood in great detail. 3D models for all 4 projects could potentially be introduced to the technological platform. • In all four urban development projects the approach to determine the energy consumption and CO_2 emission for the urban area has been by working with energy intensities (e.g. same as specific energy demand for the North Harbour case study). The energy intensities for buildings may be different from project to project depending on the level of ambition for sustainability, construction period etc. However, the methodology applied is the same. This suggests that all four urban development projects will be able to use the UEP-tool developed in T5.4 if the stakeholders decide to make use of the technological platform. • The possibility of defining different scenarios is already available through the technological platform using the UEP-tool including choosing energy supply technologies, specific energy demand for buildings and determining the effect on CO_2 emissions (as demonstrated in T8.3). However, the cost impact related to the scenarios is yet to be implemented and should be included in the technological platform in the further development. • Other functionalities that are not implemented in the technological platform yet are the possibility of making projections in the scenarios using the UEP-tool. This is important in most green field projects, where stakeholders have committed themselves to low carbon emission (or in some cases even carbon neutrality) in the full life time of the urban development project and new buildings will be built covering the entire urban area. • The functionality of reporting as an integrated part of the technological platform would have been very helpful in both the project planning/competition phase and in the project reporting phase for all four green field projects described. A brief report template with all relevant parameters and main analysis results, simple graphs and the 3D model itself would be of great value.

Urban development projects in Denmark, Spain and UK	**Contributions to the technological platform**
Spain	
• "Sagrada Familia" Partial Plan • Fàbrica Nova Especial Plan • "Sector Study" work within the context of the Urban Master Plan of Manresa revision.	• Including the cost parameter in the analysis carried out using the tools developed to guide the decision making process is extremely relevant. • When working with large urban areas introducing information at building level might become useless, as there is little level of detail and not very concrete. In these situations, the users of the technological platform may be able to identify energy intensities for large areas of urban development rather than identifying the exact building parameters. Options allowing this sort of information could be very useful in the technological platform. • Since shadows affection has been seen as one of the most important parameters to be considered in the Spanish case when deciding between different urban structure options (it affects not only sun exposure but percentage of windows in facades and potential sun-depending energy systems), it has become important that the tool developed allows the user to easily interact with shapes of different building typologies, meaning rotation, movement, extrusion, etc. all within a nicely usable 3D environment. • In most of the policies requirements addressed in the studied urban development projects, the CO_2 emission parameters identified seem to be the most transversal parameters, which could be used to compare with other policy requirements in other urban development projects. CO_2 related parameters will allow a comparison of the effect of CO_2 emission reduction policies (e.g. energy efficient urban lightning, mobility management etc.) across different urban development projects. It seems that this is one of the most important parameters which should be highlighted in a final report developed by the technological platform when the user has carried out an analysis using the tools developed.
UK	
• Middlehaven, Middlesbrough • Hulme, Manchester Leicester Square Mile • Gateshead BIG	• There would be a clear additional functionality if it were possible to integrate costs (construction / refurbishment) into the platform, albeit this would be necessarily crude due to the actual availability and commercial sensitivity of accurate costs. While some large commercial databases on new building and refurbishment costs are available, there would be additional functionality within the technological platform if the relative cost impacts were able to be calculated. • Many of the procedural concerns around a mix of formal statutory planning and informal community involvements would benefit from better visualisation and communication of the data. The provision of choice between 2D and 3D visualisation may aid the appropriate representation of different scales of socio-economic data sets. • Lifestyle parameters that impact on household and area-wide CO2 emissions perhaps present some of the most significant challenges for the development of the SEMANCO platform. Hence, the potential for the SEMANCO platform to extend the typical household income levels to make these sort of 'ecological foot printing' calculations could be considered where stakeholders have a particular interest in a more holistic approach to reporting overall resource consumption and carbon emissions.

7 CONCLUSIONS

7.1 Contribution to overall picture

The mapping of the key parameters relevant to CO_2 reduction and the requirements related to policy, data, stakeholders and technological development in a total of 11 urban development projects in the three case study countries has confirmed the potential applicability of the SEMANCO platform and the tools developed so far beyond the three case studies in Newcastle, Manresa and North Harbour. Even though this was assumed at the outset of the SEMANCO project it has now been validated by the work carried out in T6.2.

7.2 Impact on other WPs and Tasks

As described in the DoW the work presented in this report "will be used to further situates the analysis of the problem domain conducted in T6.1 *Defining the problem domain and scope of the tools within the case study scenarios* within the analysis of how the tools developed in T 5.4 *Prototype of the integrated platform* can be more generally applied". The applicability has been confirmed as mentioned above.

Hence, the work which has been done in T6.2 represents a valuable input to T6.3 *Developing the implementation strategies*, where a conceptual model for the tool implementation in WP8 will be developed. The conceptual model will be more robust by considering and testing its applicability on 11 urban development projects compared to only three case studies.

Work in T6.2 serves as a good starting point for approaching the stakeholders involved in the 11 urban development projects to present and demonstrate the SEMANCO prototype platform and the tools developed to get their feedback and interest. This directly relates to the work that will be continued in T7.4 *Exploitation planning* dealing with the creation of potential spin-off initiatives originating from the project outcomes and taking the technological platform to potential new clients by partners involved in energy-related planning.

Finally the work conducted in T6.2 provides input to T8.4 *Analysis and conclusions of the implementations* dealing with the comparison with other benchmarks and projects to verify wider applicability. Once T8.3 *Intermediate report on implementation* -dealing with the evaluation of the implementation process after the second iteration round related to demonstration scenarios for the three case studies- has been completed, a wider perspective including all potential 11 urban development projects can be taken.

7.3 Contribution to demonstrations

The contributions to the technological platform identified and summarised in section 6.3 could be taken into account in the demonstration scenarios for the three case studies (e.g. North Harbour, Manresa and Newcastle) to be completed in T8.3, providing that some of the suggested functionalities are implemented. This would certainly help to improve the demonstration of the platform functionalities from both an energy analysis and usability point of view thereby increasing the possibility of attracting new stakeholders to the SEMANCO platform.

7.4 Other conclusions and lessons learned

The main results and conclusions have been addressed above. Some other lessons learned and reflections in the process of completing T6.2 are given below:

- A common set of key parameters used to describe urban development projects strengthens

the applicability of the technological platform and tools developed. It has been possible to identify these for the projects in Denmark and Spain, but not for the UK.

- Even though the tools integrated in the SEMANCO platform (e.g. SAP, URSOS and UEP) are used to address specific circumstances in each case study country they could have a wider applicability in urban planning dealing with ambitious CO_2 reduction targets. For instance, some of the feedback received from the Spanish stakeholders is suggesting benefits of applying the UEP-tool working with energy intensities for buildings and urban areas instead of specific building simulation tools.
- Even though many of the key parameters are energy and CO_2 related the cost parameters could potentially have a greater impact of developing the urban project. This is the case for all urban development projects in the three case study countries and even in the EU and at an international level considering the financial difficulties and challenges in many countries since the global financial crisis. This suggests that more importance should be given to the cost parameters in the analysis and decision-making process supported by the SEMANCO platform and tools.
- The mapping of the urban development project shows that parameters related to energy efficiency and CO_2 reductions are very often not an integrated part in the project from the beginning and in some cases they are totally absent. This puts a greater responsibility on the urban planners (architects, engineers etc.) to introduce these at the start of the planning process. It could be done by linking them to an overall sustainable planning approach or concept.
- The more urban development projects are mapped and analysed in the SEMANCO context the stronger the possibility of exploitation of the technological platform and the tools developed. A strategic alliance with different platforms (e.g. Covenant of Mayors)*)* and other programmes and projects could potentially increase the number of urban development projects included in SEMANCO after the project life time.

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9 APPENDICES

APPENDIX A. Crib sheets for urban development projects

A1. Denmark

The feedback from the urban development projects addressed in the Denmark is summarized in the table below:

- Vinge and Copenhagen Cleantech Park, Municipality of Frederikssund
- Køge Coast, Sustainable Urban Development
- Fredericia C, the Amsterdam of Jutland
- Risø Park, development of a Science Park at DTU Risø Campus

Table A1. Crib sheet for Vinge and Copenhagen Cleantech Park, Municipality of Frederikssund

Urban development project/Requirements	**Vinge and Copenhagen Cleantech Park, Municipality of Frederikssund**
Policy Requirements	The main objective of this project was to develop energy scenarios for the energy infrastructure in the new city Vinge and Copenhagen Cleantech Park (CCP) at St. Rørbæk in collaboration with commercial and public partners and to make proposals for a sustainable transport and drainage/water supply infrastructure. The purpose of the energy scenarios was to come up with a suggestion for a relevant energy infrastructure for Vinge and CCP from a socio-economic point of view addressing the goal of CO_2 neutrality for Vinge envisioned by the Municipality of Frederikssund. In this way the project is more ambitious compared to the local policies of the Municipality of Frederiksund (e.g. targets of 20% CO2-reduction in 2020) and national policies (e.g. independency of fossil fuels in 2050). The scenarios represent relevant alternatives of energy supply that all municipalities in practice have to decide upon in the municipal energy planning process. The work was initially commissioned by the Municipality of Frederikssund in close collaboration with Business Frederikssund (the local business and trade promotion organisation in the Municipality). Among the most significant local requirements from the Municipality of Frederikssund was that all possible interactions and synergies in the energy supply system from a wide variety of both conventional and new energy technologies on the market had to be analysed, with particular focus on security of supply, economic viability, flexibility and potential for energy storage. Each energy supply scenario included an assessment of the individual energy technologies based on the technological stage of development. This made the analysis very challenging and it was difficult to make very decisive recommendations as to which energy scenario would be the most optimal one. The consumer and socio economic evaluation of the energy scenarios showed a little variation. The project was supported by the Danish Energy Agency (DEA) financially thorough a grant. However, DEA also required co-financing from the public and commercial partners involved in the project. The project specification was to some extent influenced by the partners involved, Sustainability is high on the agenda in most urban development projects carried out in Denmark due to the ambitious visions and targets by local and national government. This makes it easier to get funding for projects that would increase the possibility of developing carbon neutral new cities. The target of CO_2

Urban development project/Requirements	**Vinge and Copenhagen Cleantech Park, Municipality of Frederikssund**
	neutrality is however not mandatory and ambitions can be reduced if they are not supported by financial and/or socio economic criteria.
Data Requirements	The initial project data suggesting different scenarios for the development of the urban area (number of e.g. houses, working places, inhabitants etc.) was provided by the Municipality of Frederikssund. The classification of energy performance standard for houses and commercial buildings were discussed and recommended by the energy consultants and commercial partners involved in development of energy efficient housing and approved by the Municipality. The energy data (e.g. key figures for electricity and heat consumption for buildings) was discussed and estimated by the energy consultants. All other data (e.g. estimation of energy demand, energy supply, CO_2-emissions, costs) was calculated by the energy consultants. All data has been documented in the project report and is available in Danish on the Web site of the Municipality and can be accessed and referenced as well. The initial project data described above is very uncertain as most forecasts usually are for green field urban development projects with a time horizon of 50-60 years. The energy scenarios and models developed are however flexible and can be updated with new data if project conditions and assumptions change.
Stakeholder Requirements	The project consortium consisted of a mix of public and commercial partners. The project owner was the Municipality. However, the Municipality appointed Business Frederikssund as the Project Manager. A steering group was established consisting of project owner, project manager and the public and commercial partners. The actual analysis was carried out by the energy consultants from 3 different engineering companies. Moreover, an Advisory Board was established covering the most important stakeholders involved in the urban development project. Project results were presented to the Advisory Board at meetings (4 meetings during a year) to get their feedback and recommendations.
Technical Requirements	In the project period different engineering calculations tools were used to make the necessary calculations related to the different energy scenarios. Since energy consultants from 3 different engineering companies were involved individual tools owned and used by these companies were used for the analyses. The tools used were simple excel or access based tools. A GIS-mapping tool was used to identify local renewable energy sources. A simple excel spread sheet tool was used to calculate socio-economic and consumer economic effects for the different energy scenarios. The steering group was not so interested in which tools were used since this was the domain of the energy experts but rather what results came out of the analyses. The project manager was however interested in obtaining the excel spread sheet tool with all the calculations and results. Some visualizations were produced based on the data from the GIS mapping tool showing the development in energy demand in the geographic area of Vinge and local availability of renewable energy sources. No 3D model or map was available for Vinge, which could have been useful in the project especially to visualize the energy systems (e.g. solar heating, PV-systems, wind mills) and energy infrastructure (e.g. district heating network, heat accumulators).

Table A2. Crib sheet for Køge Coast, Sustainable Urban Development

Urban development project/Requirements	**Køge Coast, Sustainable Urban Development**
Policy Requirements	The vision for Køge Coast is to create a unique, attractive and sustainable community that strengthens Køge's role as a centre in the metropolitan area, in Zealand and the total Region. The vision focuses on these six vision points: Culture, retailing, infrastructure, creativity and quality, public involvement, sustainability. The Municipality of Køge and a private development company have joined forces in a partnership for the development of the Køge Coast project. In the Køge Coast project sustainability covers both environmental and energy-related factors, for example in the form of compact residential construction, which provides a range of environmental benefits. Moreover, the urban development project will be carried out on a sustainable basis from the perspectives of health and social welfare. There was no comprehensive political vision/objective concerning reduction of CO_2 and other greenhouse gases for the district or geographical area of Køge Municipality. However, climate was and is high on the agenda at global, EU, national, regional and municipal level. The Danish Government has decided that Denmark in the long term must be independent of fossil fuels like many municipalities have started to make energy and climate plans to ensure significant reductions in greenhouse gas emissions within their geographic areas. Since the new urban area is part of Køge City which lies within the Municipality of Køge geographical area, the energy consultants suggested that the district from a net perspective over a total period of the next 20 years should be CO_2 neutral itself and contribute to the rest of Køge City and the Municipality of Køge by making it more CO_2-friendly. The work was initially commissioned by the Municipality of Køge and a private development company through the launch of an open competition between different consortiums consisting of engineers, architects and other partners. The energy strategy was developed by the energy consultants working on the sustainability features of the urban development project. The work was centralized around suggesting, describing and calculating approx. 10 energy and CO_2 related indicators and scoring these within a benchmark framework. The most sustainable suggestions and solutions were given the highest score. The expected CO_2 emission 2010 - 2030 was estimated from the energy strategy chosen which combines a selection of the most flexible and economically viable measures available to reduce CO_2 emissions. First phase of the competition was a prequalification phase, where the different consortiums had to submit general documents incl. CV's and references and a sustainability vision for the urban area. This phase was not funded by the project owner. 7 consortiums were prequalified in the second phase of the competition and had to describe a master plan for the urban area. This phase was funded with a minor amount. In the third phase 5 consortiums were shortlisted to actual develop the master plan for the urban area. This phase was funded as well with a minor amount. Finally a winner was announced based on the suggested master plan. A small amount was allotted to all 5 teams and the winner got a double amount. The step by step approach gave a long time period to consider and work on the proposed master plan for the area and to go into more details in describing the sustainability features in the project as well. In general the funding for participating in the competition was very limited. It did however not influence the quality of the work since it is foreseen that these competitions do not generate a big income for consultants. It is a visionary project that in the long run could generate income for consultants who would participate in developing the urban area. Sustainability is high on the agenda in most urban development projects carried

Urban development project/Requirements	**Køge Coast, Sustainable Urban Development**
	out in Denmark due to the ambitious visions and targets by local and national government. This makes it easier to get funding for projects that would increase the possibility of developing carbon neutral new cities. The target of CO_2 neutrality is however not mandatory and ambitions can be reduced if they are not supported by financial and/or socio economic criteria.
Data Requirements	The initial project data suggesting the development of the urban area (e.g. number of square meters of area for houses, shops, offices and cultural institutions, working places etc.) was provided by the Municipality of Køge and a private development company. Much of the data used to document and calculate the analysed energy and CO_2 indicators was provided by the energy consultants based on their knowledge from other projects/cases in both inside and outside the geographical area of the Municipality of Køge and also from literature study (e.g. technology, costs, energy efficiency and renewable energy potentials). All data has been documented in a memo and is available in Danish on the Web site of the Municipality and can be accessed and referenced as well. The initial project data described above is very uncertain as most forecasts usually are for green field urban development projects with a time horizon of 50-60 years. The indicators calculated and analysed are however flexible and can be updated with new data if project conditions and assumptions change.
Stakeholder Requirements	The project consortium consisted of several commercial partners (e.g. architects, engineers, research companies). The project was headed by the architects in the competition phase, which is often the case in urban development projects. The proposals from the project were presented on 3 seminars during 2010 to a jury consisting of 7 members from Køge Municipality and the private development company and finally at a public meeting arranged by the jury.
Technical Requirements	In the competition period a simple excel spread sheet calculation tool was used to make the necessary calculations related to indicators. Each indicator was defined, described and calculated. Furthermore the input needed to calculate/determine the indicator was highlighted as well. The simple excel spread sheet tool was used to calculate socio-economic and consumer economic effects for the chosen energy strategy. The jury was not so interested in which tools were used since this was the domain of the energy experts but rather what results came out of the analyses. Some visualizations were produced in form of simple excel figures showing the development of CO_2 emissions from electricity, heat, transport and the net CO_2 emission combined for the geographic area of Køge Coast. No 3D model or map was available for Køge, which could have been useful in the project especially to visualize the energy systems (e.g. solar heating, PV-systems, wind mills) and energy infrastructure (e.g. district heating network, heat accumulators).

Table A3. Crib sheet for Fredericia C, the Amsterdam of Jutland

Urban development project/Requirements	**Fredericia C, the Amsterdam of Jutland**
Policy Requirements	The physical concept for Fredericia C consists of establishing canals that open the area to the Little Belt (sea) and brings the water all the way into town. Moreover, the concept of the development plan comprises a number of strategies to support the implementation and realisation of the development plan and the visions underlying the plan.

Urban development project/Requirements	**Fredericia C, the Amsterdam of Jutland**
	The visions for Fredericia C are: •It is both compelling and innovative as well as respectful of the old part of Fredericia •It lets the quality of life go hand in hand with great quality in town building keeping a keen eye on tomorrows possibilities •It sees active participation from the citizens, commerce and culture in Fredericia as an asset and as a necessity for good development •It creates a new role for Fredericia as a key player in the "Trekantsområdes" (region) competition with Copenhagen, the capital of Denmark •It incorporates state of the art sustainability in economy, climate and health in both planning and solutions Fredericia C will be spread over an area of 204.345 m2. The development plan is based on a fundamental principle that the development of Fredericia C must be sustainable in the broadest sense of the word, i.e. in relation to the environment, energy and climate, health and social issues as well as financially. And the ambition is to set new standards for urban development in Denmark within all these three main areas: 1: Fredericia C will take steps to create a carbon-free urban district and will therefore demand low-energy buildings and supply of alternative energy sources, such as surplus heat and photovoltaic cells (PV-systems). 2: A mix of housing types, retail outlets, cultural offerings, etc. will contribute to creating a diverse and inclusive urban district with room for everyone. At the same time, the urban district will encourage play and movement and, in that fashion, contribute to improving health. 3: The development of Fredericia C must naturally also be financially viable and, in addition, the project must meet an imperative requirement of high quality. The energy strategy chosen combines a selection of the most flexible and economically viable measures available to reduce CO_2 emissions with a balanced focus on reduced demand and sustainable energy supply. The work was initially commissioned by the Local Authority of Fredericia and a private development company named Realdania. Through the launch of an open competition between different consortiums consisting of engineers, architects and other partners. The energy strategy was developed by the energy consultants working on the sustainability features of the urban development project. The energy strategy chosen combines a selection of the most flexible and economically viable measures available to reduce CO_2 emissions. Together the strategy offers a carbon neutral Fredericia C, contributing actively to the transformation of the Danish energy economy. The strategy increases the land value by offering the future land owners access to financially competitive and sustainable energy supplies, which have only little impact on the freedom of building design. Three energy scenarios were developed to guide the strategic focus: - a baseline scenario assuming regular building standard, conventional supply of heat (district heating), conventional supply of electricity and no particular measures to move towards more sustainable transport - an energy efficient scenario, assuming that buildings are designed to meet low-energy standard by measures taken within the cadastre, plus measures to switch to more sustainable transport means - low-energy scenario based on wind energy, where the low-energy

Urban development project/Requirements	**Fredericia C, the Amsterdam of Jutland**
	requirements are met by producing wind outside of Fredericia C on large cost-effective wind turbines. Like scenario 2 this scenario assumes sustainable transport measures. The analysis showed that scenario 3 would be the most cost effective one in offering a CO_2 neutral urban area, offering a true combination of environmental, economic and social sustainability. The project competition was carried out in 2 phases. Phase 1 was a competition with seven participating teams. In this phase the participating teams each delivered a process description and a project description that showed how each team would unfold project vision. In Phase 2 a parallel assignment was carried out where four teams participated, to get more specific suggestions as to how the project could be implemented sustainably and carried out physically. The whole or some elements of process descriptions, project descriptions and proposals for the development of the urban area could subsequently be implemented in the final development plan. Throughout the process Fredericia C required that citizens and stakeholders continued to be involved in the process so that good suggestions and observations from them could go into the final development plan. In general the funding for participating in the competition was very limited. It did however not influence the quality of the work since it is foreseen that these competitions do not generate a big income for consultants. It is a visionary project that in the long run could generate income for consultants who would participate in developing the urban area. Sustainability is high on the agenda in most urban development projects carried out in Denmark due to the ambitious visions and targets by local and national government. This makes it easier to get funding for projects that would increase the possibility of developing carbon neutral new cities. The target of CO_2 neutrality is however not mandatory and ambitions can be reduced if they are not supported by financial and/or socio economic criteria.
Data Requirements	The initial project data suggesting the development of the urban area (e.g. number of square meters of area for houses, shops, offices and cultural institutions, working places etc.) was provided by the local authority of Frederica C and the private development company. Much of the data used to document and calculate the analysed energy and CO_2 indicators was provided by the energy consultants based on their knowledge from other projects/cases in both inside and outside the geographical area of the Municipality of Frederica and also from literature study (e.g. technology, costs, energy efficiency and renewable energy potentials). All data has been documented in an Excel spread sheet and memo and is available in English and can be requested by contacting the energy consulting company. The initial project data and the three energy scenarios developed are very uncertain as most forecasts usually are for green field urban development projects with a time horizon of 50-60 years. In the Frederica C project the time horizon however is only 20-25 years.
Stakeholder Requirements	Fredericia C P/S is the partnership in charge of developing the new town district of the same name. The partnership is limited by shares set up between the Local Authority of Fredericia and Realdania By, of which the Local Authority of Fredericia holds 25% and Realdania By 75%. The project is run by a professional board of directors, appointed by Realdania By and the Local Authority of Fredericia and composed of representatives of both parties.

Urban development project/Requirements	**Fredericia C, the Amsterdam of Jutland**
Technical Requirements	In the competition period the 3 energy scenarios were developed in LEAP and output results were exported to Excel to make the visualizations. The jury was not so interested in which tools were used since this was the domain of the energy experts but rather what results came out of the analyses. Some visualizations were produced in form of simple excel figures showing the CO_2 emissions and fuel consumption in the baseline, annual costs of energy and energy savings and CO_2 emissions and fuels in the 3 energy scenarios. No 3D model or map was available for Fredericia C, which could have been useful in the project especially to visualize the energy systems (e.g. solar heating, PV-systems, wind mills) and energy infrastructure (e.g. district heating network, heat accumulators).

Table A4. Crib sheet for Risø Park, development of a Science Park at DTU Risø Campus

Urban development project/Requirements	**Risø Park, development of a Science Park at DTU Risø Campus**
Policy Requirements	The Risø Park project is the development of a Science Park at DTU Risø Campus. The science park is meant to make new links between research institutes and businesses with access to unique test and demonstration facilities. The aim is to become Europe's leading research and business cluster for clean tech companies. The vision of the park is to become a Danish reference that can help realize the vision of Denmark as a green growth laboratory. The aim is that the science park and the interaction with Risø, Roskilde University, other knowledge institutions and a wide range of companies in the energy, environment and climate industries will be able to create a Danish showcase of the latest technologies, smartest processes and the most sustainable solutions. The work was initially commissioned by the Municipality of Roskilde with the purpose of establishing the foundation for the local development plan for the urban area. A section of the report deals with specific requirements in the development plan in order to realize the suggested energy strategy. The purpose of the energy scenarios has been to come up with a suggestion for a relevant energy infrastructure for Risø Park from a socio-economic point of view addressing the goal of keeping the CO_2 emissions as low as possible. Furthermore the purpose has also been to investigate new combinations of energy supply technologies, examples include district heating in combination with very large decentralized heat storages. In the project three different scenarios for the energy supply were identified and analysed: • District heating with supply from the local district heating company in Roskilde • Central energy supply (thorough establishment of/connection to central heating, large heat storages, large heat pumps and electricity grids) • Decentralized energy supply (at village or cluster community level) in particular focusing on solar heating and wind turbines The scenarios are furthermore compared to a baseline scenario with natural gas as fuel, and with another scenario using low-energy buildings to minimize the energy consumption instead of using alternative energy in the energy supply. The scenarios represent relevant alternatives of energy supply that all municipalities in practice have to decide upon in the municipal energy planning process. Possible interactions and synergies in the energy supply system from a wide variety of both conventional and new energy technologies on the market have been analysed, with particular focus on security of supply, economic viability,

Urban development project/Requirements	**Risø Park, development of a Science Park at DTU Risø Campus**
	flexibility and potential for energy storage. Each energy supply scenario includes an assessment of the individual energy technologies based on the technological stage of development. The energy scenarios were suggested by energy consultants after winning a competition suggesting an urban development plan together with architects. The Municipality of Roskilde arranged hearing meetings with citizens and stakeholders in order to involve them in the process so that good suggestions and observations from them could go into the final development plan. In general the funding for participating in the competition was very limited. It did however not influence the quality of the work since it is foreseen that these competitions do not generate a big income for consultants. It is a visionary project that in the long run could generate income for consultants who would participate in developing the urban area. Sustainability is high on the agenda in most urban development projects carried out in Denmark due to the ambitious visions and targets by local and national government. This makes it easier to get funding for projects that would increase the possibility of developing carbon neutral new cities. The target of CO_2 neutrality is however not mandatory and ambitions can be reduced if they are not supported by financial and/or socio economic criteria.
Data Requirements	The initial project data suggesting the development of the urban area (e.g. number of square meters etc.) was provided by the Municipality of Roskilde. Much of the data used to document and calculate the analysed energy and CO_2 indicators was provided by the energy consultants based on their knowledge from other projects/cases in both inside and outside the geographical area of the Municipality of Roskilde and also from literature study (e.g. technology, costs, energy efficiency and renewable energy potentials). All data has been documented in an Excel spread sheet and memo and is available in English and can be requested by contacting the energy consulting company. The initial project data and the three energy scenarios developed are very uncertain as most forecasts usually are for green field urban development projects with a very long time horizon.
Stakeholder Requirements	The science park - Risø Park - will be operated by Scion DTU, and behind the project is in addition to Roskilde Municipality and DTU also RUC Roskilde University, Zealand, SEAS-NVE and Siemens. The area is planned to be expanded from 2014-2030, and Risø Park is expected to lead to at least 2,000 new direct jobs.
Technical Requirements	In the competition period the 3 energy scenarios were developed in a simple Excel spreadsheet. The Municipality of Roskilde was not so interested in which tools were used since this was the domain of the energy experts but rather what results came out of the analyses. The architects on the other hand were very interested in visualizations that could in a simple way illustrate the energy scenarios and the suggested energy system. Hence, a diagram was produced showing the energy system and other visualizations were produced in form of simple excel figures showing the energy consumption, CO_2 emissions and related costs in the baseline scenario and 3-5 alternative energy scenarios. In the project also GIS-mapping was used to estimate available renewable energy sources and simple 2D-maps of actual geographic locations and drawing of the new planned urban area showing the suggested location of energy plants and infrastructure (e.g. windmills, district heating pipes, seasonal heat storage etc.). No 3D model or map was available for the Risø Park

Urban development project/Requirements	**Risø Park, development of a Science Park at DTU Risø Campus**
	project, which could have been useful in the project especially to visualize the energy systems the energy infrastructure in more details.

A2. Spain

A crib sheet helping to classify requirements and gathering CO_2 related parameters was agreed among the three case studies to be used in order to obtain feedback from the selected projects.

This crib sheet was used together with the data template for the Urban Development Project to conduct interviews with each one of the architects in charge of each one of them.

The crib sheet was also used while studying the documents defining the urban development projects.

The feedback gathered both from the interviews and from the document itself is summarized in the tables below:

Table A5. Crib sheet for Sagrada Familia Partial Plan

Urban development project / Requirements	**Sagrada Familia Partial Plan**
Policy Requirements	The work was commissioned by the Municipality of Manresa. The Urban Master Plan definitely approved in 1997 allowed the Municipality to write up this urban development plan. So, politicians and head of departments in the municipality decided that the Urban Planning Department should take care of writing the project. This was decided due to the demographic pressure to provide new schools for the city. Children in this area were going to temporary pre-constructed barracks as schools for a long time. As to the technical interest of the project, it was an area of importance, so it was meant to develop guidelines for the new future development sectors to the south and the east of the city. With regard to CO_2 emissions or energy efficiency, there are actually no mandatory procedures (international/national/local) which can influence the work of Urban Planners. The greatest concern during the work carried out by Urban Planners in Spain is to comply with a mandatory law named "Llei d'Urbanisme". It is not national, since the administration of the territory is decentralised in Spain, but regional (Catalonia). In this regard, the mandatory document only specifies the need to include an environmental study, more related to indicators such as land occupation, lighting level in the streets, air quality, water cycle, etc. Although there are policies to be met at local level (Covenant of Mayors and SEAP etc.), there are still no straight lines for CO_2 emission reduction affecting urban developments. The result of the project doesn't create new policies, but rules applicable to some others developments, such as the future ones in east sectors. None of them are related to energy consumption or energy supply, though. Current legislation concerning energy efficiency in Spain is mainly at national level. Thus, this legislation doesn't affect directly the work of Urban Planners (mainly under local competences). Anyhow, as Urban Planners are architects and they are used to designing buildings, some of the procedures affecting buildings are somehow affecting the decisions made when working at larger scales. The most important local requirement to comply with this project was to achieve a legal path to build the school before the whole sector was developed. There were no other requirements that could create barriers. Of course, there is always the cost-benefit analysis, which is always quite constraining, so you need to place a large amount of square meters so you can create a great park or construct all the required square meters of fully equipped streets, etc. There were no specific funding requirements impacting project specifications. The most important economic support was the one coming from the local government in constructing the future school. It provided the needed boost to begin with the writing of the project.

Urban development project / Requirements	**Sagrada Familia Partial Plan**
Data Requirements	Mostly, the data used for the project development is currently the one extracted from census and cadastre, mainly, for what refers to the existing buildings. Also an accurate topography is very important, and also the ownership of the properties. General data about social behaviour has been used also for mobility and environmental studies. No energy related data has been used but it would be very interesting to have the energy efficiency of the buildings, or at least concerning the energy demand. In case of using energy related data, the architect guess it would be useful to know the building characteristics of the projected blocks, such as type of walls and things like that. Regarding the energy supply, it could probably have been made a lot of sense if, when designing the infrastructure, it could have been tested to the effect of the heating energy supply with different energy sources. Without being completely aware of how equipment behaves, the team writing the project documents could have assigned a consumption rate to the proposed amount of square meter. This could have been helpful to obtain comparable values about the energy related behaviour of a concrete proposal.
Stakeholder Requirements	Since the project is promoted by the Municipality, the Urban Planning Department is in charge of leading all the process. Nevertheless, after a first proposal is submitted, the Municipality (mainly its politicians) provide the first input. This first review deals mainly with policies or social pressure concerns. After the general sketch is agreed among both parties, the basic proposal is spread to several other stakeholders, with more specific tasks, such as infrastructure, mobility, social aspects, environment, maintenance, etc. Each one of them highlights problems, provides solutions or creates new requirements. The Urban Planning Department deals with all the inputs and tries to achieve a solution that pleases all the parties. When the document is ready, it is made public to the city and affected owners are warned about this fact. At this moment, any citizen can provide its input during a certain time. All the allegations are recorded and valued. After this procedure, the team in charge of the document decides whether changes are needed or not. Legal processes are able for those affected who don't agree with the final proposal.
Technical Requirements	The actual work in urban planning only uses 2D and 3D CAD software, and reports provided by different databases. Some other specific software can be used for particular tasks, such as mobility evaluators, etc. No other software is used for a particular assessment regarding CO_2 emissions or energy behaviour of a building. In some particular cases, rough estimations have been done when large buildings are proposed, using the common tools in the market for assessing energy demand at building level, such as excel sheet in the past and simplified calculation method nowadays.

Table A6. Crib sheet for Fàbrica Nova Especial Plan

Urban development project / Requirements	**Fàbrica Nova Especial Plan**
Policy Requirements	The work was commissioned by SACRESA and RECAVE. Both were companies owning more than 90% of the land within the limits of the Special Plan. Back in 2002, companies had interest in developing the sector because the residential building market was being extremely profitable. Plus, one concrete stakeholder was showing interest in managing the commercial result of the development. The municipality was also happy when they first heard of the owners promoting this development. Of course, there were negotiations trying to better fit stakeholder's expectations with the overall objectives of the city, but when an agreement was reached, the

Urban development project / Requirements	**Fàbrica Nova Especial Plan**
	work started. Local policies are quite focused to concrete actions and procedures, without directly affecting derivative urban planning work. All the policies were listed in the Annexes of our final document (Environmental study), but so far they have not been conditioning our decisions since there is no a formal commitment to be met, concerning energy demand and such things. Actually, our work is mostly conditioned by the regional legislation concerning urban planning. Buildings have to deal with Energy Efficiency, Technical Building Code, etc. So far, urban planners can still avoid these sorts of things. There were many local policies conditioning the urban development. Most of them were related to the large park and its connection with the existing one and the new equipment (swimming pool). The project did not create new policies or new guidelines for other areas, although it is a very important project at local level, but with very concrete requirements to comply with. There is nothing directly relevant to the project, from national legislation. One of the most challenging requirements made by the owners was that we should concentrate and pack future dwellings according to their type (protected or free market). We would probably prefer to better spread the amount of square meters and so, there was a kind of discussion with them. There was also a big pressure concerning the commercial space to be created. We needed to place effort in order to attach new buildings to the existing one. No CO_2 emissions reduction requirements were made by any of the related stakeholders (Municipality or owners). Of course, economic viability was an important issue. In fact, it all started because of the interest of a particular stakeholder who was committed to manage the future commercial spot.
Data Requirements	Due to the importance of the main industrial building to maintain, historical data (blueprints, pictures,…) was used in order to understand his structure. Also geographical and topographic data was used as well. A very important package of data was also the one provided by the Municipality and supply companies, especially regarding existing supply and drain networks. As far as I know, we didn't generate new relevant data. The responsible for the environmental study was using aggregated data about the city and external statistical data, as well.
Stakeholder Requirements	These sort of private developed projects use to follow all the same pattern concerning people involved. In rough words, private owners commission the work and set a series of meeting with the Municipality, who is in charge of first approval of the final document. In sensible cases like the one we are speaking about, negotiations at political level are made, and current feed-back is done among technicians from the Municipality and the project authors. After the local approval, regional institution has to approve the result as well. As far as there were only three interested parties (owners), there were no extra difficulties in this particular case, and mainly the barriers to overcome were related to economic and profit issues. Most of the meetings and agreements were reached during the preparatory stage. During the phase of writing down the proposal, mostly technical difficulties were to be solved. Of course, frequently feed-back between the authors (us) and clients was present all along the process.

Urban development project / Requirements	**Fàbrica Nova Especial Plan**
Technical Requirements	No particular tool was used for assess CO_2 emissions or energy efficiency at all. Nevertheless, as for the case of solar panels (which was a local requirement at building level at the moment the document was written), we used a kind of simple excel sheet for check in the future availability to accomplish with this mandatory procedure. For the rest of the work, usual CAD software was used.

Table A7. Crib sheet for "Sector Study", Urban Master Plan of Manresa revision

Urban development project / Requirements	**"Sector Study", Urban Master Plan of Manresa revision**
Policy Requirements	The work was commissioned by the Municipality of Manresa. The Urban Master Plan definitely approved in 1997 is actually largely expired. Although it is frequent to extend the validity if Urban Master Plans, the actual regulation sets the longevity of this document for a period from 10 to 15 years top. The commissioning of this work was in the agenda of almost all the political parties running for the last elections. Plus, the national economic situation concerning the construction sector, actually aground, places the urban planning of the city in a comfortable situation for making new decisions and prepares the city for news paradigms to come. Undertake the POUM revision in a Municipality is always set under a huge background of local policy requirements. Meaning that the political party who commissions the work always has specific requirements, beginning with the selection of the team. In this case, the policy requirements under the work have nothing to do with CO_2 emissions or environment issues. They are more concerned about the social acceptance both the process of the work and the final result, as it was clear during political campaign that many citizens in Manresa don't like their actual city. With regard to CO_2 emissions or energy efficiency, there is only on single mandatory procedure influencing the work, at a very slight level. The most important parameters nowadays deal mainly with economic and social issues. The only mandatory procedure which could, somehow, reflect relevant energy parameters is the Sustainable Environmental Report. It is written by an external team, and deals with green areas, water, geology, paths, land consumption, etc. and also refers to the Covenant of Mayors and the PAES document, analyses aggregated figures of energy consumption, and places in the map the already existing energy sources within the boundaries of the municipality. It is expected that the previously related document, when the work begin with the phase of writing the proposal, can provide some inputs to be taken into account. Anyhow, historically it has not been a very important point conditioning the decisions of POUM revisions. The project has not yet created new policies for the city, but it will. Sadly, very few policies or new energy related rules are foreseen. The whole output document (POUM) itself refers to all policies affecting the city, at many levels. Including the ones more closely related to energy efficiency, energy consumption and CO_2 emissions. Its final relevance in the final picture is something still to be defined. The local requirements defined for this work are highly relevant for the development of the project. For instance, it has been required to regularly engage the society in the on-going process. This concrete requirement is creating additional cost for sure, and probably some delay. There have been no specific funding requirements so far. Of course, the budget available in the Municipality is tight, as all of them are nowadays, but nothing special. Again, economic interested parties are quite concerned of the work carried out in the POUM office, and many of them put some pressure in the decision making process. Sometimes it can lead the work to undesirable situations.
Data Requirements	The data used within the work is mainly either currently available or created by the Urban Planning Department, cadastre, census, etc. External experts are making use of other sources, more general and aggregated extracted from regional or national governments. The only energy related data used in the development of the work is that already available through the SEAP document within the municipality, or general data extracted from

Urban development project / Requirements	**"Sector Study", Urban Master Plan of Manresa revision**
	statistical studies or more aggregated one coming from utilities. One of the most important sources is the Catalan Energy Institute. This organisation gathers many reports and relevant data about energy consumption at regional level. So far, there has been no need to assume cost for the data needed for a proper project development.
Stakeholder Requirements	The Municipality has chosen a team for leading the work development. One specific office has been enabled to fit with this purpose. This team is in permanent contact and making use of a bunch of resources from the Municipality itself, such as not only previous historical documents or data, but also person effort. This is so because the process is meant to be quite transversal, involving many departments from the actual administrative structure of the City Council. Each one of these departments/persons is gathered through specific commissions, meeting in a 15 days basis. Some of the commissions are Old City, Mobility, Activities, Social memory, Public equipment, etc. There is no commission which deals with energy or CO_2 related parameters, though. Each one of these work teams creates their input for the whole final document. It is reviewed by the leader team and later on by politicians. Depending on the issue and/or the moment even a referendum asking for citizen's opinion could be made. Finally the document needs the approval of the regional government.
Technical Requirements	The team is making use of the current tools for urban planning, both in 2D and 3D. We are also working with GIS software for data manipulation, and of course, a lot of administrative software. So far, there is no particular software for assessing CO_2 emissions at any level in the POUM revision.

A3. UK

Table A8. Crib sheet for Middlehaven, Middlesbrough

Urban development project / Requirements	**Middlehaven, Middlesbrough**
Policy Requirements	The project was one of several strategic regeneration priorities identified by the elected mayor of Middlesbrough. At the time, there was an often repeated phrase that "we have to prioritise our priorities", reflecting the large number and range of projects that the municipality and the public sector partners were engaged with. The procurement approach was to generate interest and excitement (or possibly commercial and planning 'hype' within the trade and professional press) around the approach to the project through the running of a national competition. This was initially presented as a time-limited opportunity to become a regeneration partner in one of; what was now presented in policy, as a 'priority site'. The private sector stakeholders that eventually won the competitive tendering were included as part of a competitive dialogue when the proposals were developed in more detail. The private sector partner eventually selected through this competitive process introduced the notion of 'One Planet Living' as a central tenant of their proposed submission and approach. This was consistent with their wider advocacy for environmental foot-printing using the 'One Planet Living' methodology in their other current development locations. This was an underlying value set for the ethical / sustainable developer which was clear in the precedent developments for sustainable communities that the company had been involved in design, development and their on-going management. When selected they had the intention to be in Middlesbrough for the long-haul. "… regeneration probably (has) a better chance of achieving sustainability than out-of-town locations … urban design with sustainability as the guiding principle is a fantastic opportunity to do something really special and enable residents to live sustainable lifestyles". (Riddlestone, 2011, p.21). The company had been responsible for the research and development of ecological foot-printing methodologies and had already published a series of environmental indicators at the scale of the nation state, including the national energy footprint "… the fastest growing component of the global ecological footprint" (Loh & Wackemagel, 2004 p14) and the use of footprint indicators (Rees, 2000; Rees & Wackernagel, 1996). The intent behind the development and selection of this sustainability was to make a relationship directly between household income levels, lifestyles and their actual environmental impact. The technique has since then been applied to community scale developments from their conception (Desai 2005) through to development and management, using strategic KPIs that included fuel poverty, household capital and on-going fuel costs, sourcing sustainable materials, recycling, health, speed of construction and development as well as CO_2 emissions, renewable energy and CHP output (James & Desai, 2003). There was also a strong private sector belief that this was an integrated and accessible measure for sustainability that would be attractive to key segments within the property market. "... it's this ecological footprint which is at the heart of OPL. This timely invention measures the impact each of us makes on the planet. ... OPL must also be straightforward ... (the principles are) all important and they're all interconnected". (Desai and King 2006 p8 & p15-16). This was clearly a commercial decision. There was a keen awareness of international benchmarking of sustainability standards (NHBC 2009) and the interest that higher levels of sustainability could attract to the regeneration project. The 10 principles of one plant living were retrofitted into the original Alsop strategic framework (Anon 2006) and used as the basis for a site-wide sustainability strategy. While the One Planet Living approach to ecological foot-printing remains a corporate commitment for the local authority and many partners, it has been less significant in the later stages of the development. This was the inevitable implication of the developer (Bioregional Qunitain) closing the Middlesbrough arm of their company after the first few buildings were completed. Once the developer left the site, their sustainability standards left as well.

Urban development project / Requirements	**Middlehaven, Middlesbrough**
Data Requirements	The 'One Planet Living' methodology is based on a mix of generic and localised data integrated into an ecological foot-printing framework that was initially established by Bioregional in partnership with the WWF and the SEI (Stockholm Environmental Institute). This approach is largely based on typical household resource consumption (Wiedmann *et al*, 2006) aggregated at a national or regional scale. For individual households within Middlehaven or other areas in Middlesbrough this allows for a relative comparison with similar areas or demographics. As such, it has been considered as a useful way to incentivise and encourage behavioural change to make more sustainable decisions at the household level. Data is collected at household level based on typical consumption levels for a range of resources. This primary data is aggregated to a settlement or regional scale based upon demographic (occupancy and income) data sets.
Stakeholder Requirements	The enforced changes to the regeneration strategy following the withdrawal of Bioregional Qunitain have had implications for engagement and project management structures. The 'new' political emphasis is very much on project delivery and maintaining some form of momentum and action. People want to see things happening at whatever rate of building rather than more plans and reports. Thus, there are several initiatives impacting on the later stages of the Middlehaven development. One phase has taken the political emphasis on employment and business development, giving rise to a new St Hilda's Enterprise Zone. This is a simplified planning zone; created through the use of a LDO Local Development Order) that provides additional business rate relief for targeted employment sectors. In the case of Middlehaven this is specifically Digital Businesses (TVU 2011). The strategy for residential development has moved towards the later phases of the master plan being delivered through experimental approaches to supporting custom-building. The hope is now for multiple small-scale stakeholders with a strong emphasis towards individual specification and control in the form, quality and sustainability of development. There are key aspects of the spatial layout, morphology and the appropriate scale of development within individual development plots are controlled through a regulating plan and design code. Guidance for prospective stakeholders; as a mix of custom-builders, community scale developers and individuals; (Middlesbrough Council *et al* 2013) no longer sets out a minimum requirement for energy efficiency and sustainability. Throughout the different phases, the key stakeholder engagement is with those interested in living and / or developing in Middlehaven. This has been at the expense of local community engagement which has been fairly confrontational around financial incentives, ownership offers and relocation packages.
Technical Requirements	Recently, the foot printing tools are become available as web-based assessment software (Roelich *et al*, 2013). However, much of the emphasis of the technical requirements remain in-house as part of the core business of Bioregional. As a business they have continued to look at ecological foot printing as the more integrated mechanism for the measurement of sustainability at a variety different scales. This has included address local municipality and settlement scale considerations with the promotion of OPL as a 'badge' for assessment and aspirations. The OPL methodology has been adopted by Middlesbrough Council (One Planet Middlesbrough) and continues to form the basis for many aspects of strategic decision-making by the municipality and its strategic regeneration partners.

Table A9. Crib sheet for Hulme, Manchester

Urban development project / Requirements	**Hulme, Manchester**
Policy Requirements	The background for the redevelopment of Hulme is complex and typical of many of the challenges of northern English conurbations. The area in inner city Manchester, was suffering from poor images and identity concerns as much as a failing physical environment. Policy was established over a long period 10-15 years and thus was subject to significant changes in funding and priorities regarding national urban policy. The initial policy framework was provided by 'City Challenge', leading to input as much as guidance for the UK's Urban Task Force (established in 1999 by Lord Rodgers and including many of the politicians and professionals who had worked in the initial stages of the Hulme regeneration) and the work of the Urban Villages Forum. More recently, significant funding coming from the Housing Market Renewal Pathfinder programme that, while having a priority on the regeneration of housing in low demand areas, also dealt with investment in employment, education and community infrastructure.
Data Requirements	The "integrated assessment" model of Ravetz (2000) was used to inform the sustainability assessment. This took the form of a 'metabolic model' of the city and used four primary indicator categories: drivers, activities, resources and impacts. The range of appropriate data reflected some of the local and national politicians' interest in urban autonomy. Thus, the interest in overall resource consumption and the development of a common basis for measurement. This holistic methodology used energy, water, waste, food and transport as the key input and output parameters – in effect creating a local version of an environmental foot-printing methodology for the city-region, neighbourhood and single developments. The idea seemed to be as much about a simple and understandable 'model' or framework for assessment. For each key resource, there was an input measure and an output measure. As an example for energy, this was broken down into a neighbourhood heat demand (input) and electricity demand (input) and then used to plan for a locally balanced system for local renewable heat generation (output) and electricity production for CHP and PVs (output). The intention was to meet the local demand with a local system of production. The second intention was to use the same framework for assessment and planning at different scales of operation, with examples produced for a single building / block development within Hulme
Stakeholder Requirements	Perhaps the most significant aspect of the state of the estate in the late 1980's and early 1990's was the way that paternalistic government organisations and agencies, form national to regional to local – did things form the benefit of the community but largely without the involvement of the community. Subject to 'forced' regeneration due to the proximity to Manchester city centre. Decision-making was undertaken through the Hulme Sub-Committee with a full range of delegated council powers. The importance of this was evident in the leader of the council chairing this sub-committee, with senior members and cross-party support. This sub-committee was able to be responsive and make rapid decisions that effected the regeneration of the area while maintaining full accountability regarding the use of public finance. As experience and evidence grew around the benefits of this type of organisational structure that could provide rapid support for planning, disposal and land assembly, it became the 'organisational and management model' for other regeneration projects across Manchester. The principle delivery vehicle for action was Hulme Regeneration Limited, a public private partnership / joint venture between Manchester City Council and Amec. Community representatives and local business members were empowered and sat on the joint venture board alongside council and business representatives. The approach was informed by an extensive 'community audit' and an assessment of community group needs There was a strong procedural understanding of what sustainable development meant for urban regeneration. Principally that is long-term, strategic and fully integrated between physical and socio-economic considerations (Carley and Kirk 1998). There

Urban development project / Requirements	**Hulme, Manchester**
	was the development of a shared vision for sustainable regeneration between all of the project stakeholders. This need for a shared strategic vision and a thematic starting point was informed by Regional Planning Guidance. Strong emphasis and bias towards social housing as the topic to address early within the regeneration processes. The urban design and morphology was controlled through a bespoke design guide (Hulme Regeneration Limited, 1994).
Technical Requirements	Technical requirements were in effect quite minimal – with basis input and putout parameters being used within a local bespoke spreadsheet and databases. The most significant elements were around the availability and sourcing of the most accurate data sets for different patterns of resource consumption. Energy assessment was undertaken using the most appropriate model available (generally basic SAP assessments) for a suitable cost. This was developed in more detail at the city-region scale (with Manchester City Council leading the energy modelling (demand and supply) for the greater metropolitan area. Data was collected and modelled on a common GIS platform (ESRI ArchView as used by most local municipalities within the metropolitan area) and disaggregated as far as possible to a resolution that was suitable form planning at a neighbourhood level.

Table A10. Crib sheet for Leicester Square Mile

Urban development project / Requirements	**Leicester Square Mile**
Policy Requirements	The framework for the project has been influenced by a number of national initiatives designed to replace the Decent Homes initiative (a programme of works to bring the social housing stock within England and Wales to a reasonable and qualitatively defined standard). These new initiatives include the Green Deal and the ECO. Green Deal is a national programme of invest to save, where the cost of physical works are supported by a government loan subject to quality control (use of an approved Green Deal assessor and meeting the 'golden rule' in the form of a pay-back period of typically seven years). Several local authorities and housing associations are hoping to implement their own versions of this financial support model, albeit with fewer issues around red-tape with the intention of reduction costs. The ECO is the Energy Companies Obligation, where the largest six energy providers in the UK have been collecting a surcharge on household bills that have to be spent to reduce CO_2 emissions to meet a legally binding target. Typically this is about targeting hard to heat homes, those living in fuel poverty and properties outside of the mains gas networks. The policy requirements around scaling-up refurbishment remains fairly dynamic and most stakeholders, including then national government, are reviewing their practices and seeking to find a workable solution through trial and error of policies as much as a top-down imposed policy framework.
Data Requirements	Within the project there is flexibility over the use of the most appropriate data sets. Indeed pragmatism is expected to get the best targeting solution without excessive data acquisition costs. There are principally three different sources being used. Firstly a set of publicly available Energy Performance Certificate records. There was supplied in rather simplistic Landmark EPC (Energy Performance Certificate) data export files that simply provided a final rating without any of the actual input data on building geometry, services and systems. This was identified as a secondary data set, presented as a summary output of the EPC / SAP calculations rather than the actual SAP input sheets. The result was a certain level of recalculation from output to actual specification input, for example, in the star rating / range of boiler efficiency being used as the basis of actual %

Urban development project / Requirements	**Leicester Square Mile**
	boiler efficiency. This resulted in several attempts to retrofit the 'input data' used for the sap calculations. Secondly, there was the extensive use of Google Streetview This formed the basis of a desk-top survey to check the input data assumptions and to make an assessment regarding typical windows and overshadowing. There was also some additional interest in the actual age of the property, as the project wasn't at that stage using any open source data on property construction age bands. In some instances, this was supported by primary street survey 'drive-by' assessment where StreetView was unavailable. Thirdly, use of the 2011 Census data. This incorporated a series of socio-economic and occupancy data sets as the basis for normalisation. There is the current testing of a cost database being connected to the package of measures. This dataset has been developed through a voluntary supply-chain network of providers of physical materials and instillations services. This is attracting a lot of interest as a real cost database provided by local suppliers – a useful model for extending to other areas.
Stakeholder Requirements	There is a significant overlap between stakeholders and customers. The partnership has initially identified large scale housing associations which have significant stock to be refurbished, replaced or similar. This is the initial stakeholder group. However, political interest has added wider community interests, particularly the interest in the establishment of a Community Energy Trust or similar to the delivery side. There is a level of political and institutional mistrust with municipalities, registered housing providers and large commercial energy providers amongst many householders. There is a feeling that a not-for-profit community based group could be more successful, procedurally, in getting interest and take-up of a package of retrofit measures, particularly with private landlords and owner occupiers within the pilot area. Discussion around the issues of behavioural changes and the benefits for carbon reduction. The intention is to present a lifestyle assessment and advice on property energy management alongside a package of physical works to the property.
Technical Requirements	Technical services have been provided by an independent consultancy, working in partnership with social housing providers and training organisations. As such, the technical requirements are deemed to be provided through an appropriate commercial service provider (that targets areas / properties of poor energy performance, due to age, condition, size etc.) using a mixed set of open source, commercial and partner / internal organisation data sets. This has been utilised within CROHM (Carbon Reduction Options for Housing Managers), a bespoke piece of software that has been developed as a proof-of-concept model. Initial this is being targeted at large housing stock managers (primarily public / municipal and social sectors) with an interest or obligation at addressing fuel poverty, running costs and energy reduction within such stock. The CROHM uses commercial SAP output information, in combination with building stock information (desk-top survey and stakeholders' own housing stock databases) and then displays this using GIS platform. In each case, the software used is adapted commercially available spreadsheets, SAP models and GIS packages. Implications are around software costs for acquisition and annual maintenance.

Table A11. Crib sheet for Gateshead BIG

Urban development project / Requirements	**Gateshead BIG**
Policy Requirements	At the strategic level, the master planners have had an important role in imagining what a sustainable community would mean for Gateshead. They have described the initial development site at the Freight Depot as a "showcase for the future possibilities of sustainable neighbourhood living" (EgretWest, 2011). This approach is an effective response to the outline development briefs and guidance created for the 19 separate project areas. It is a notional commitment to the shared visions and aspirations with the outline design stage approach to what the physical form and urban capacity may look like, based on an approach to repeating housing typologies and forms. At the site and building scale, Gateshead Council has begun to use planning conditions to require sustainability standards higher than the national building regulations. This is using the Code for Sustainable Homes as the most appropriate national standard and the policy echoes the approach by 'Evolution Gateshead'. As a requirement for the BIG agreement, all new homes have to be built to a minimum of Level 4 of the Code for Sustainable Homes. The government initially set out a stepped / phased approach towards increasing sustainability standards (CLG 2006) towards zero carbon development by 2016. There have been several significant changes to the detail within the Code for Sustainable Homes. Changes are justified as … "streamlining the standard and processes … to ensure that the Code is focussed on the issues of greatest significance … [and] … balancing sustainability policy aims with the practicalities of house building in the current economic climate" (CLG 2009 p10) and include heuristic knowledge arising from practice based review of achieving the desired / required code standards. Albeit a damming review of the proposals by the House of Commons Environmental Audit Committee (2013) found they would 'significantly dilute' the current approach to delivering zero carbon housing with 'the lowest common-denominator'. They found the principal driver behind the review was the lowering of costs associated with achieving the higher levels of the CSH but that not real account was taken of the evidence that provides this cost. Practical experiences relate to construction systems and the difficulties moving from design stage to scheme implementation. Also includes some degree of reflection on the additional construction costs (recorded construction costs measured as uplift per metre square against standard unit built to current Building Regulations), the expected cost reductions to further schemes (arising from better knowledge of systems, technologies and management processes required, and particularly the aspect of scale of development, where growing case study evidence collected by the industry body suggested that larger scale developments will find it easier and more cost effective to comply with the Code requirements (UKGBC 2008). At a strategic scale there have been significant issues regarding the relationship between standards, definitions and the statutory planning system as it initially emerged in planning guidance (CLG 2007). Changes and reforms to the statutory planning system continue to seek simplification and consistency with other statutory and regulatory instruments. Thus, the planning system reforms and guidance have a clear bias towards the use of nationally recognised and standardised measures, even breaking the Code down to set planning requirements against individual sections of the code. However, many of the practical experience stress the importance of detailed definitions used in the Code assessment process that have consequences for data requirements. The relevant national policy context for achieving carbon reduction through planning at the time of the production of the statutory plan was set out in Planning Policy Statement 22 (ODPM 2004a) and supporting guidance (ODPM 2004b) supplemented by revisions to Planning Policy Statement 1 (CLG 2007) that requires local planning

Urban development project / Requirements	**Gateshead BIG**
	authorities to set local requirements for decentralised and renewable or low carbon energy to serve new development and recommends all commercial and residential development to be designed with a minimum of 10% of the energy requirement provided by renewable resources generated on site (Ove Arup and Partners, 2009). At the local scale, the setting of standards has been informed by the local authority Carbon Reduction Strategy and the use of Sustainable Construction Supplementary Planning Document.
Data Requirements	There are several issues around changing national standards that are impacting on data requirements. There is an on-going issue regarding definitions and precision of energy calculations (CLG2010) as they have proved to be problematic between different professional disciplines, and more extreme whenever political decision-making and community engagement was a significant element of the project. Industry bodies have widened the argument for off-site solutions as part of the definition of zero carbon, as a pragmatic means of delivering renewable energy to properties. In effect this is allowing for site specific issues to be considered at a community scale or above, with contributions / support for the provision of new energy infrastructure, and "…. the basis for a significant growth in community-scale technology" (UKGBC 2008 p5) that can mitigate for the carbon emissions of the development. There have also been potential inconsistencies highlighted between the Code's definition of zero carbon development and the use of SAP. Specifically there is a worry about SAP and the assumptions made for carbon content for energy (electricity) imported from the national grid.as these vary from those figures presented by DEFRA (ref) – having an impact on the calculation of zero carbon and off-setting. In short, the UKGBC felt that SAP over-estimates the carbon-savings achieved by certain technologies Guidance has put forward an argument for consistency in methods and definitions between different English regions (LUC & SQW, 2010) to assess the most appropriate way to achieve the regional carbon reduction and renewable energy capacity targets set at that time (Arup & Partners, 2008). Guidance is intended to provide a more robust evidence base, and thus speed up the statutory planning system with regard to renewable technologies and energy infrastructure. While this has since been surpassed in guidance, following the change in government and the abandonment of regional spatial strategies, the principles of the approach have formed the basis of additional changes in the statutory planning system. LZC technologies being permitted development (ref) and national infrastructure being promoted through?/ (ref). Although, it is yet to be see whether these policy instruments will affect any quicker or more informed decision making.
Stakeholder Requirements	There were multiple stakeholders involved as the partnership was established following a national / international competitive tendering competition followed by 30 months of detailed competitive dialogue with a number (initially this included as many as 15 separate development partners) of short-listed consortia. The Council contribution towards the consortium will be the package of assets, land and buildings, to be used to effectively underwrite and secure finance for construction. Thus, 'Evolution Gateshead' is an asset backed delivery vehicle, with additional financing, technical support provided by the private sector. It is anticipated that the majority of the technical advice will be provided by in-house technical teams created (or expanded existing teams) within the private sector partners. The political agenda was about obtaining better quality and sustainability for the Council by thinking in the medium to long-term and supporting delivery of stated objectives rather than speculative development.

Urban development project / Requirements	**Gateshead BIG**
	In practice, the definition of zero-carbon development is, in part, dependent on political control at both the national and local scale. The definition of zero carbon remains dynamic as it depends on input from SAP, which is regularly updated. Although the intention and direction of policy instruments remains relatively clear there is a level of practical pragmatism in response to a changing economic context and technical debates. Not least in Gateshead, where there is strong political support for a local ESCo (Energy Supply Company) for the provision of community scale renewable energy. Part of the local flexibility has presented itself as locally 'allowable solutions' and some policy exceptions. A key element to the project delivery was the competitive approach to partnership working with the private sector. Industry shows an environmental bias in the understanding of sustainability as the expense of socio-economic concerns (Opoku & Ahmed, 2013) in part because these are more quantitative and thus understandable to many of the key professions within construction. This was a truism within the private sector responses to Gateshead. A significant factor in the procedural approach is that of sharing the development risks, rather than risk minimisation or avoidance. Being aware of the risks and having some means of measurement and quantification in a formal project risk assessment has been an important issue. For all of the commercial stakeholders, there has been a regard for organisational reputation and trust. The long timescale involved and the commitment from each of the partners means that quality, sustainability and deliverability will all inform this reputation. Politicians and chief executives have all been on-record regarding their commitment to these shared goals and objectives. Consideration of integration with existing communities has been addressed with quite a lot of semi-structured community involvement using a variety of working groups and task groups, particularly the recruitment and training of local residents as part of an Urban Design Reference Group (Gateshead 2013) who had direct input into the partnership proposals.
Technical Requirements	Arising out of the BIG agreement, the public / private consortium 'Evolution Gateshead' has been investigating realistic and achievable construction methods that have a strong bias towards fabric first solutions and the consideration of off-site and modern methods of construction to achieve this. It is anticipated that many of the possible construction systems will be constructed to a higher level of quality control that traditional construction techniques having high thermal specifications (including thermal bridging), good air-tightness but with differences in thermal mass. The requirement for CSH4 should be achievable through a fabric first solution, with the potential for changes to the energy supply and / or a corresponding decarbonisation of the national supply. They have suggested some technical difficulty resulting from the inclusion of SAP calculations as part of the Code assessment and the definition of zero carbon – with an impact where the definition suggests changes to the SAP calculation method. In effect this means there is a requirement to use appropriate software and support tools that relate directly to the nationally recognised and mandated standards, as there are effectively the only long-term standards and measures that can be used within planning policy and enforcement[5]. To date, this has be addressed by effectively outsourcing the technical assessment (for example; CSH assessment, SAP

[5] This recent requirement for national standardisation of sustainability standards for new-build; and potentially sustainable refurbishment; projects is limited to statutory planning mechanisms. Where the local municipality is a regeneration partner (typically as site / property owner, promoter or funder) there is the option to require a more localised and bespoke set of standards and requirements. However, in practice there is still a bias towards the use of the recognised national standards, as a complete measure at a higher level, or by requirements for certain credits within specific categories referred to within such standards.

Urban development project / Requirements	**Gateshead BIG**
	assessment) to the project developer and their technical consultancy team. There is a requirement for applications to use an appropriate energy modelling software package. There is a number of useful energy modelling packages that can be used in support of initial design work. Most significant one is Carbon Mixer, which contains a bespoke set of climate data for the North East of England Region and has been used within the region as a tool to assist the implementation and monitoring of Regional Spatial Strategy Policy 23. Other tools provided for early stages planning work included C-Plan (www.carbonplanner.co.uk) and Vantagepoint. While these can used in a similar manner as predictive SAP scores and are encouraged by the local planning authority to aid the early discussions and the development of an appropriate energy and carbon reduction strategy, the requirement for establishing a baseline energy requirement has to be calculated using approved Communities and Local Government / Building Research Establishment software[6] or by agreement over alternative energy modelling tools with the local planning authority. Much of the technical information is in the cost benefit analysis on the provision of community scale energy provision. Using a mix of existing demand and potential demand (heat and electricity consumption and peak demand) at an aggregated area or site level derived from a notional site capacity. The assumed site capacity is often based on a simple gross density of development, although within the Gateshead BIG there are actual design schemes that help to provide a more realistic capacity. There are a variety of specific technical tasks that require modelling. For example, the need for an air quality assessment using dispersion modelling (using either the ADMS 4.1 and AERMOD air quality models) and heat loss, distribution and sizing calculations (appropriate software sizing package such as Hevacomp or other approved) as part of the detailed requirements when considering CHP design.

[6] The current list of approved SAP software http://www.projects.bre.co.uk/sap2005/ and non-domestic http://www.ukreg-accreditation.org/ND-ApprovedSoftware.php under the Department of Communities and Local Government Building and Energy Calculation Software Approval Scheme [BECSAS].