SEVENTH FRAMEWORK PROGRAMME

THEME 6: Environment (including climate change)

Contract for: **Collaborative Project**

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Socio-Economic and Environmental Workshops Report

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1. Introduction

1.1 Purpose of the document

This document is Deliverable 5.1 – *Socio-Economic and Environmental Workshops Report*, produced from Task 5.1 – *Assessment of Driving Forces and Pressures on Environmental and Socio-Economic Systems in Urban Environments*. The **aim of this document** is to present both the methodological framework and the participative approaches applied for the identification of planning priorities and the definition of sustainability objectives and indicators. It also presents the results of the stakeholder meetings held in the BRIDGE case studies (Athens, Firenze, Gliwice, Helsinki and London).

1.2 Acronyms

BRIDGE	sustainaBle uRban plannIng Decision support accountinG for urban mEtabolism
CoP	Community of Practice
DPSIR	Driver-Pressure-State-Impact-Response
DSS	Decision Support System
EC	European Community
GIS	Geographical Information Systems
MCA	Multi-Criteria Analysis
MCDM	Multi-Criteria Decision Making
WFD	Water Framework Directive
WP	Work Package

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1.4 Project overview

Urban metabolism considers a city as a system and distinguishes between energy and material flows. “Metabolic” studies are usually top-down approaches that assess the inputs and outputs of materials, water, energy, etc. from a city, or that compare the metabolic process of several cities. In contrast, bottom-up approaches are based on quantitative estimates of urban metabolism components at local scale, considering the urban metabolism as the 3D exchange and transformation of energy and matter between a city and its environment. Recent advances in biophysical sciences have led to new methods to estimate energy, water, carbon and pollutants fluxes. However, there is poor communication of new knowledge to end-users, such as planners, architects and engineers.

BRIDGE aims at illustrating the advantages of considering environmental issues in urban planning, with particular focus on specific metabolism components (energy, water, carbon, pollutants). BRIDGE’s main goal is to develop a Decision Support System (DSS) which has the potential to propose modifications on the metabolism of urban systems towards sustainability.

BRIDGE is a joint effort of 14 Organizations from 11 EU countries. Helsinki, Athens, London, Firenze and Gliwice have been selected as case study cities. The project uses a “Community of Practice” (CoP) approach, where local stakeholders and BRIDGE scientists meet on a regular basis to learn from each other. The end-users are therefore involved in the project from the start. These meetings are used to discuss and define the key sustainability issues for each city. These provide the basis to consequently determine the objectives and associated indicators, as well as their relative importance, which would help assess planning alternatives with the overall goal of promoting sustainable development.

The BRIDGE project integrates key environmental and socio-economic considerations into urban planning through Strategic Environmental Assessment. The BRIDGE DSS evaluates how planning alternatives can modify the physical flows of the above urban metabolism components. A Multi-Criteria Decision Making (MCDM) approach has been adopted in BRIDGE DSS. To cope with the complexity of urban metabolism issues, the indicators measure the intensity of the interactions among the different elements in the system and its environment. The objectives are related to the fluxes of energy, water, carbon and pollutants in the case studies. The evaluation of the performance of each alternative is done in accordance with the developed scales for each criterion to measure the performance of individual alternatives.

The energy and water fluxes are measured and modelled at local scale. The fluxes of carbon and pollutants are modelled and their spatio-temporal distributions are estimated. These fluxes are simulated in a 3D context and also dynamically by using state-of-the-art numerical models, which normally simulate the complexity of the urban dynamical process exploiting the power and capabilities of modern computer platforms. The output of these models leads to indicators which define the state of the urban environment.

Several studies have addressed urban metabolism issues, but few have integrated the development of numerical tools and methodologies for the analysis of fluxes between a city and its environment with its validation and application in terms of future development alternatives, based on environmental and socio-economic indicators for baseline and proposed situations. The innovation of BRIDGE lies in the development of a DSS integrating the bio-physical observations with socio-economic issues. It allows end-users to evaluate several urban planning alternatives based on their initial identification of sustainability objectives. In this way, sustainable planning strategies will be promoted, based on quantitative evidence in relation to energy, water, carbon and pollutants fluxes.

1.5 Setting the Context

A series of workshops with stakeholders were proposed by WP5 for the identification of sustainability objectives and indicators. However, in the light of the CoPs approach adopted within BRIDGE and considering its participative structure and potential to provide local knowledge, perceptions and concerns, the indicator workshops were combined with the CoP meetings. Thus, the anticipated two indicator workshops were substituted by the participation of WP5 members in the first and second round of CoP meetings held in each case study. In addition, a final indicator session was incorporated into the Umbrella CoP meeting, where representatives from the case study cities discussed and agreed a common set of sustainability objectives and indicators.

2. Methodological Framework

2.1 Introduction

There is no consensus on what city size, form, and spatial distribution of activities best facilitate the rational allocation of natural resources and minimise environmental impacts (Alberti, 1996). Furthermore, in urban contexts, a perfectly sustainable situation is difficult to achieve. However, urban planning can aim at improving the current situation with regards to its sustainability. The specific local problems with regards to the lack of sustainability contribute to a different definition of objectives for an evolution of the system towards a higher degree of sustainability. In other words, there can be no single definition for sustainability equally applicable to all urbanised areas, communities or man-made environments. Each urbanised area has its particular historical, cultural, social and economic characteristics. Similarly, each urban node has a planning system with individual approaches to design, building materials and development patterns, as well as to transport, services, waste management and energy use. As a result, a spectrum of urban systems can be found throughout Europe, where different sustainable development objectives and planning elements to achieve these are prioritised.

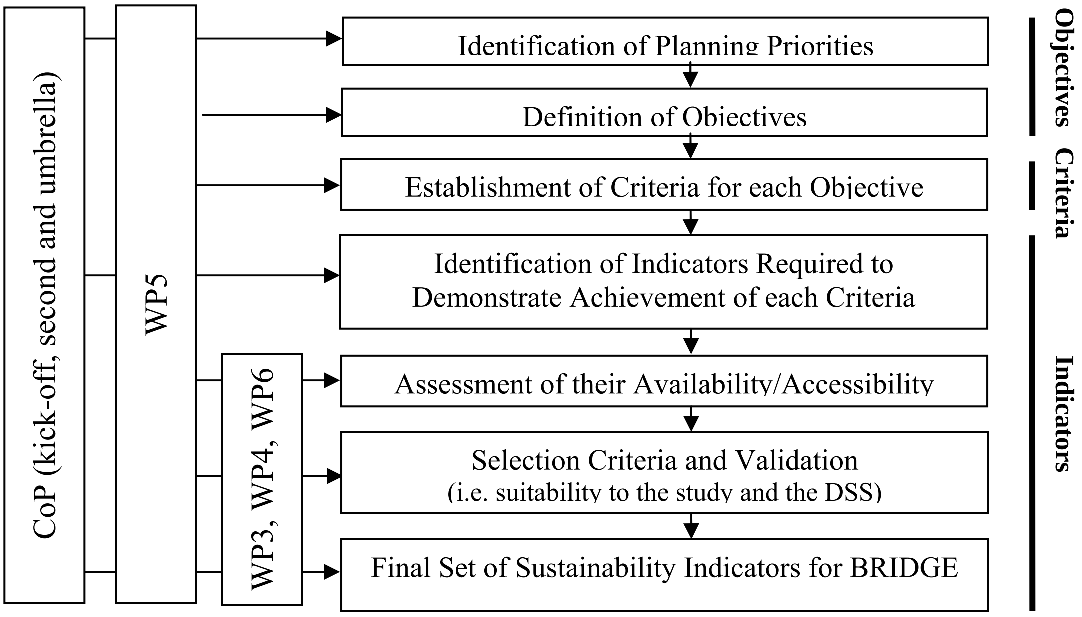
In the light of this, and despite the fact that an overarching goal has been defined by BRIDGE (i.e. sustainable urban development), the final set of sustainability objectives will be specific to each case study. Hence, the criteria and indicators associated to those objectives also need to be tailored to the requirements of each of the five case studies within BRIDGE. In all cases, the final set shall include indicators that are: critical for decision-making (i.e. address core issues); linked to sustainable planning (i.e. the domain of interest); and can be monitored (i.e. DSS compatible and measured on a regular basis).

The project aims at making the tools and approaches relevant to all cities across Europe by: a) choosing case studies that cover a wide variety of urban contexts in order to provide sufficient and varied examples; and b) ensuring that the DSS offers enough flexibility to produce tailor-made results for other European.

2.2 Conceptual Framework

A conceptual framework for the development of objectives, criteria and indicators was developed to aid this process (Figure 1). It integrated familiar indicator development concepts such as DPSIR, causal networks and decision-support frameworks. It applied the enhanced DPSIR framework proposed by Niemeijer and de Groot (2008) when defining the core objectives and identifying a potential indicators set; it incorporated the decision-support framework proposed by Donnelly *et al*. (2006) to define criteria and preliminary indicators; and applied a set of common criteria based on SMART (Schomaker, 1997) to finally select individual indicators. In all cases, the indicators were discussed and agreed at the corresponding CoP meetings.

Figure 1. *Steps of the Framework for the Development of Objectives, Criteria and Indicators.*



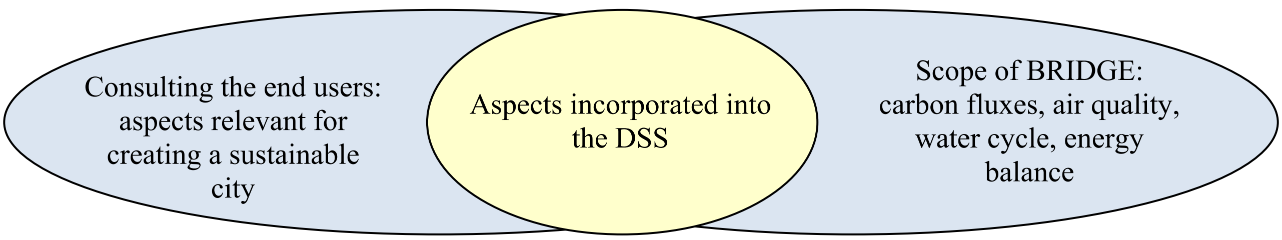
2.3 Steps in the Conceptual Framework

The conceptual framework is based on a combination of both top-down and bottom-up approaches for defining sustainability objectives, criteria and indicators:

- Top-down is applied through conceptual models like DPSIR and literature on indicators by BRIDGE researchers;
- Bottom-up is used to gather end-users' opinions on what is needed via CoP's.

These two approaches do not entirely overlap, but the area where they intersect is what will become part of the DSS (Figure 2). The choices made in the project are limited by the knowledge and resources available in the BRIDGE team. Although it may not fully cover all the requirements for assessing planning alternatives in the case study cities, it is considered that the integrated approach represents a significant step forward.

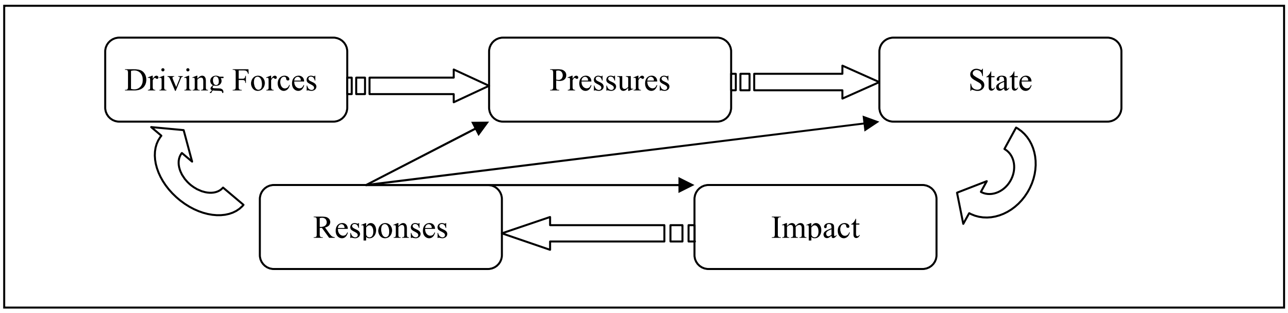
Figure 2. *Schematic representation of the conceptual framework.*



Method for Establishing Objectives

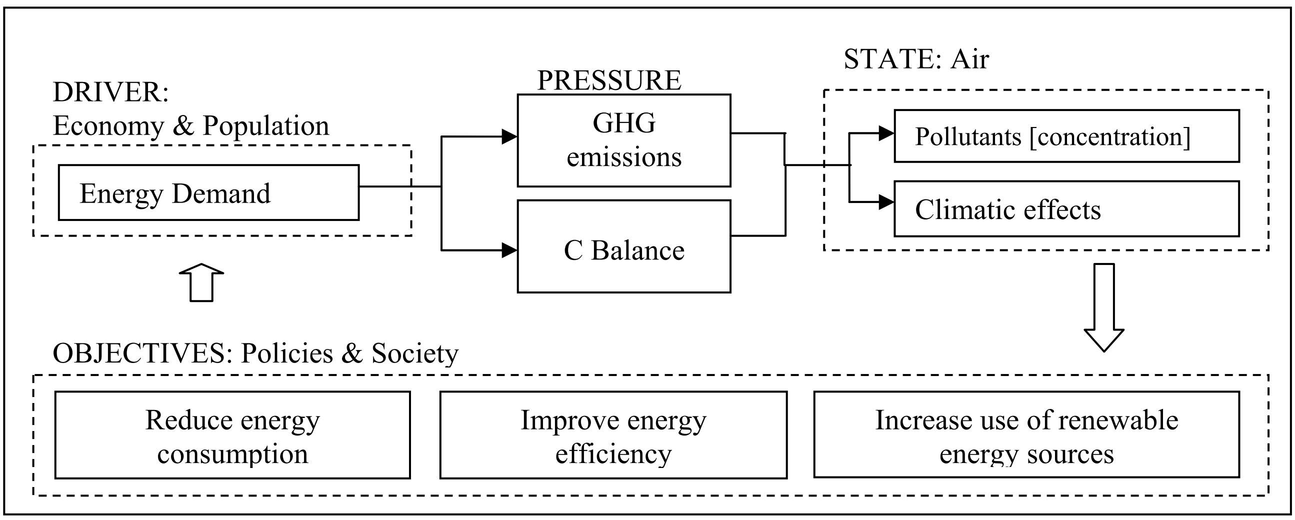
The enhanced DPSIR approach (Figure 3) provided a framework for selecting sets of indicators within an analytical problem solving logic based on causal networks (Niemeijer and de Groot, 2008). It presented a systematic basis for selecting an indicator set based on a domain of interest, as well as framing it within the boundaries of the system object of study. In the case of BRIDGE, the domain of interest is sustainable urban development, and the boundaries were determined by the aspects being analysed (i.e. water, energy and pollution). The identification of the drivers, pressures and policy objectives for each case study (during the relevant CoP meetings) determined the core aspects that needed to be further evaluated. This was achieved by answering the following questions: 'how do socio-economic drivers affect the environment?'; 'what are the consequent pressures on natural resources?'; and 'what do we need to do to protect/improve the state of natural resources, in particular, water and air?' The answers formed the basis of the objectives and helped formulate preliminary indicators (Figure 4).

Figure 3. *The Driving forces, Pressures, State, Impacts, Responses (DPSIR) framework.*



In the context of the DPSIR causal network, social and economic developments are considered driving forces that exert pressure on the environment, leading to changes in the state of the environment. In turn, these changes lead to impacts on human health, ecological systems and materials that may elicit a societal response that feeds back on the driving forces, pressures, or on the state or impacts directly (Smeets and Weterings, 1999). In the context of BRIDGE, this could be illustrated by the examples listed in Table 1. In order to integrate social and economic issues into the decision making process, economic and social objectives were described with separate indicators.

Figure 4. *Example of a simple causal diagram for developing objectives.*



Method for Establishing Criteria and Indicators

The DPSIR approach enables the logical development of objectives based on drivers and pressures as indicated in Figure 3. However, it entails the definition and monitoring of indicators for each of the components in the DPSIR (e.g. D=volume of water consumed; P=volume of water abstracted, S=water drop; I=number of e-coli in water; R=volume of water treated) and can lead to onerous causal diagrams. To facilitate the process and encourage planners and decision-makers to devise specific indicators suited to their urban and planning contexts (at the relevant CoP meetings), a more practical methodology for the development of indicators was proposed. According to the level of policy under discussion in each of the case studies, it was presumed that local partners already had a conceptual framework in mind, which helped them tracing back from pressure or state-indicators to processes to be modified (i.e. objectives) and vice versa. Therefore, indicators were chosen where they: (a) characterized the sustainability problem in the specific urban context; and/or (b) addressed changes generated by the process to be modified by the planning intervention to be modelled in the case study.

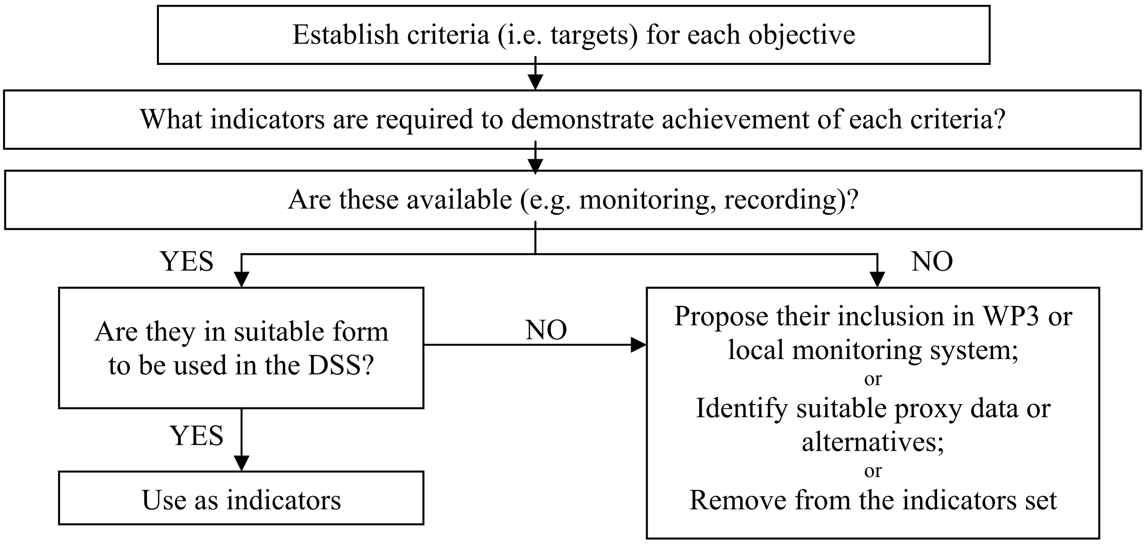
Once the core objectives were established through the DPSIR process, the potential impacts associated with the drivers and pressures were addressed for each of the environmental receptors, to determine whether or not the particular environmental receptor requires further attention (Donnelly *et al*., 2006). In the context of SEA and within the scope of BRIDGE, the focus was on energy, water, air and climate. To address sustainability in a holistic manner, socio-economic aspects were also included. Therefore, the decision-support methodology proposed by Donnelly *et al*. (2006) was applied to these environmental receptors for the definition of criteria and preliminary indicators (Figure 4) – the final set consisted of those preliminary indicators that fulfil the specific selection criteria.

Table 1. *Examples of a DPSIR approach.*

	Water	**Energy**	**Pollutants (Air/Water/Soil)**
Driver	Water demand (household, industry).	Energy demand (transport, household, industry).	Use of energy and water.
Pressure	Abstraction and wastewater.	Depletion of fossil fuels, release of pollutants and heat.	Release of pollutants.
State	Effects on water balance and water quality.	Effects on air/water quality and heat islands.	Effects of air/water/soil quality.
Impact	Resource depletion, habitat destruction and impairment, health issues.	Resource depletion, increased emissions, contamination, health issues.	Contamination, impairment of ecosystems, climate change, health issues.
Response	Reduction of water demand and improved waste water treatment.	Reduction of energy use, more energy efficient buildings/transport and introduction of alternative types of energy.	Energy demand reduction (efficiency/consumption) and increased use of renewables.

Commonly, criteria are focused and have time limits and/or thresholds associated with them that are used as a measure against which impacts may be assessed (e.g. the Water Framework Directive – WFD establishes that “good status” must be achieved in all waters by 2015). Therefore, it was essential to establish the indicators or data requirements to facilitate tracking progress towards the objectives (Figure 5) – e.g. in the light of the WFD, nitrate concentration values. Finally, it was necessary to determine whether these data were available and suitable for the final selection of indicators as described next.

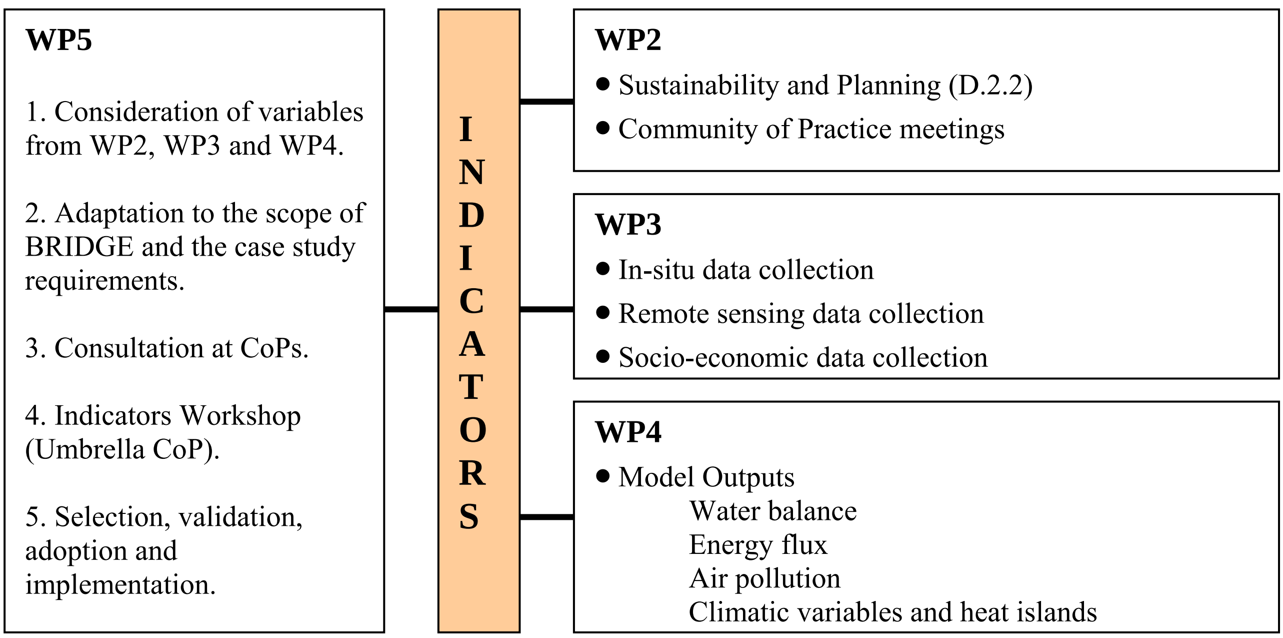
Figure 5. *Framework for establishing criteria and indicators (adapted from Donnelly et al., 2006).*



Method for Selecting Preliminary Indicators

The definition of a preliminary set of indicators was carried out in conjunction with the work undertaken by Work Packages (WP) 2, 3 and 4 (Figure 6). The sustainability objectives and the associated environmental and socio-economic indicators identified in WP2 (Karvounis, 2009) were evaluated in the light of the BRIDGE components of urban metabolism. Similarly, the data collected and analysed by WP3 (Miglieta and Magliulo, 2009), and the model outputs from WP4 (San José and Perez, 2009) were assessed and selected when valid (i.e. applicable to the relevant case study). Additional criteria and indicators derived from WP5 endeavours. These preliminary sets were discussed and further developed during the CoP meetings for each of the case study, as discussed next.

Figure 6. *Work package inputs to the development of objectives, criteria and indicators.*

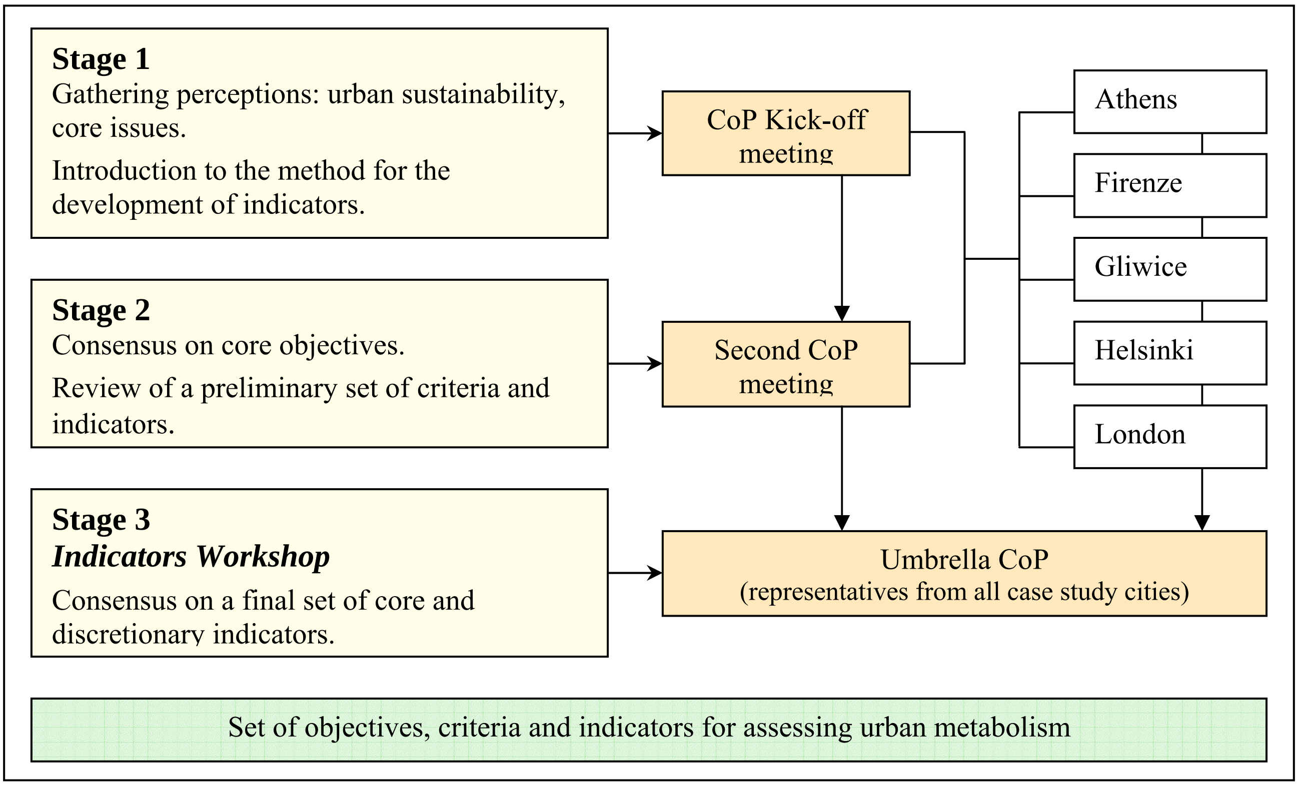


Community of Practice

The methodology steps for the establishment of sustainability objectives, criteria and indicators described above was complemented with participative consultation processes through the relevant CoP meetings.

During the kick-off CoP meetings (i.e. first round of CoPs in the case studies), the core planning issues to be addressed in each of the cities were discussed in the form of drivers and pressures. All gathered perceptions were subsequently used to determine the objectives for each case study. Consequently, a preliminary set of indicators was discussed by answering the following question: 'What indicators are required to demonstrate achievement of each objective?'. This preliminary set was made available for review and discussion at the second round of CoP meetings. A consensus was sought for the final set of indicators in the indicators workshop – as part of one of the Umbrella CoP meetings (Figure 7). Thus, the final indicators set was contextualised to each city, and grouped in: a) core – urban sustainability indicators that are common to all cases; and b) discretionary – indicators that are singular to one or several urban systems.

Figure 7. *Participative approach to the development of objectives, criteria and indicators.*



The kick-off CoP meetings varied in scope, but all included an indicators session that addressed the following aspects:

- The scope of BRIDGE: what questions should be and can be answered by the DSS.
- The conceptual approach used for the development of objectives and indicators.
- Discussing planning priorities: pressures, opportunities and challenges for sustainable urban planning and perceptions in relation to sustainability objectives and indicators

A draft questionnaire was prepared to aid the gathering of stakeholder's perceptions at the CoP kick-off meetings (Appendix A). The questionnaire addressed some of the issues highlighted by Groot *et al.* (2009) and also tackled some specific aspects relating to the development of indicators. Regrettably, responses to the questionnaire were limited (i.e. about 2-3 respondents per CoP). The questions were also used to guide the discussion in the indicators session.

During the second round of CoP meetings the objectives and indicators proposed for the sustainability of the city were revisited to fit them to the scope and requirements of the specific planning alternatives to be analysed by BRIDGE. Therefore, the second CoP meetings were based on the following questions:

- Are these objectives and indicators relevant to the case study? Do they address key issues in the area?
- What additional environmental, social and economic indicators are needed to evaluate the sustainability of proposed planning alternatives?
- Which of the indicators are available? Which are already measured?

The various objectives and indicators were compiled for each case study city, the selection criteria applied and, finally, they were validated to establish a preliminary set. This preliminary set of indicators was further discussed at the Umbrella CoP, where the final sets of core and discretionary indicators were established for inclusion in the DSS. The Umbrella CoP addressed the following aspects:

- How can we measure urban sustainability across Europe? How can the DSS be effectively applied?
- Which sustainability objectives and indicators are applicable to all cities?
- Which objectives and indicators reflect local planning issues and environmental, social and economic characteristics?

Selection Criteria

It was established from the outset that a reasonably limited number of indicators should be included in the final set. A maximum of 10 indicators for each BRIDGE component was recommended as this would provide a practical and measurable set and facilitate monitoring procedures. It was also proposed that the list of indicators be grouped into "core indicators" (i.e. common to all case studies) and "discretionary indicators" (i.e. specific to the case studies).

A number of indicator selection criteria have been developed, such as that proposed by Schomaker (1997). He suggests that indicators should be SMART: Specific, Measurable, Achievable, Relevant and Time-bound. Additional parameters may address whether they are user-driven to be relevant to target audience (CBD, 1999), or may evaluate their applicability to many areas/scales of measurement, sensitivity to change, and cost (Riley, 2000 – sighted in Niemeijer and de Groot, 2008). Based on the above parameters, the following criteria were proposed for the selection of indicators in BRIDGE:

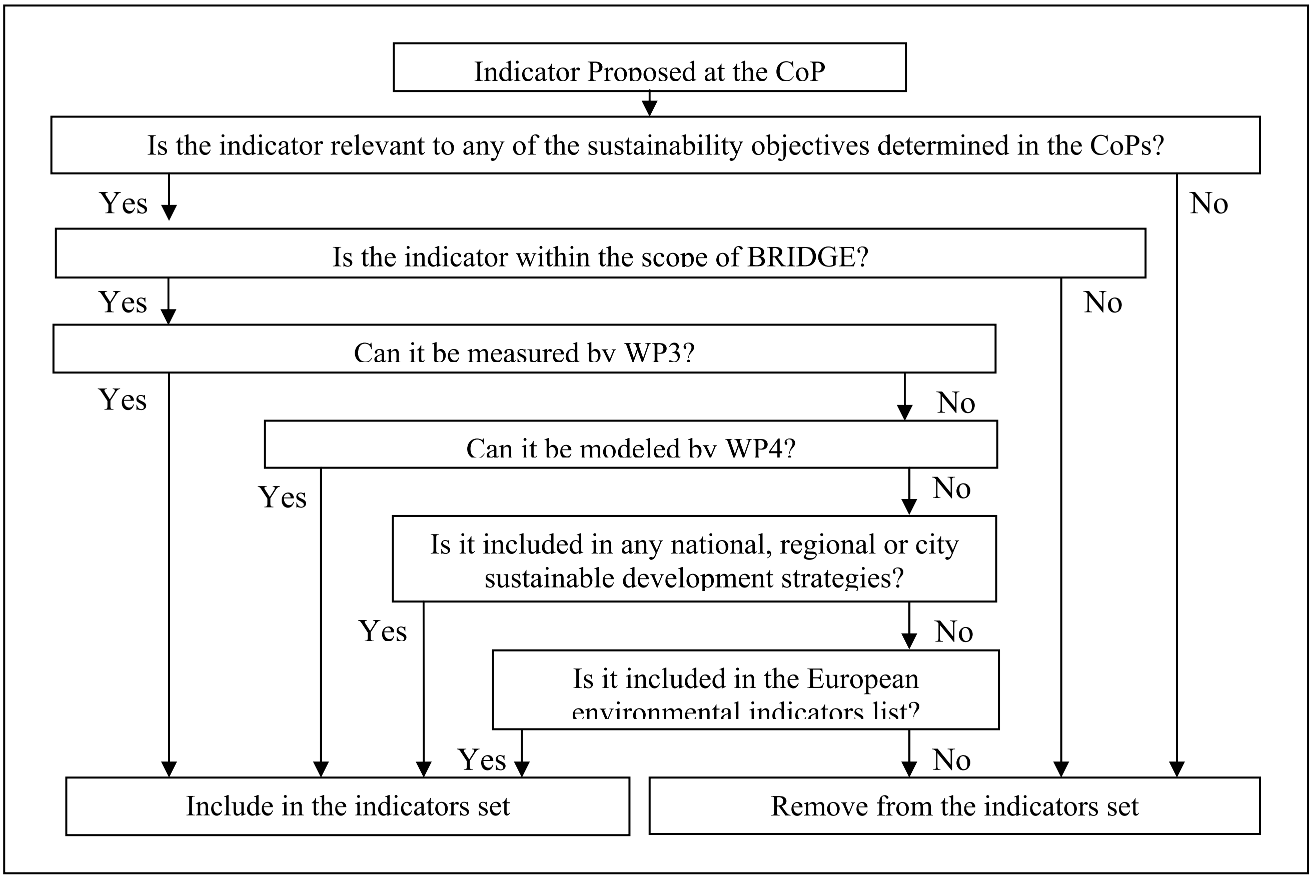
- ***Specific***: the indicator is clearly and unambiguously defined.
- ***Spatial***: the indicator links measurements to a location. This is imperative as the BRIDGE DSS is based on Geographic Information Systems (GIS) and urban planning has strong spatial connotations.
- ***Measurable***: the indicator is quantifiable and measured on a regular basis without entailing excessive cost. Monitoring procedures should be in place or could be planned for the relevant indicators.
- ***Achievable***: the indicator can be measured, collated or modelled.
- ***Relevant***: the indicator is user-driven and addresses the sustainability objectives and criteria.

- ***Timely***: the indicator can provide information sensitive to change on a timely manner within the planning and/or decision-making processes.

Validation Approach

The objectives and indicators proposed at the first and second round of CoP meetings were revised to obtain a final set, and discussed at the Umbrella CoP to reach a final consensus. The revision of CoP outcomes included comparison with existing sustainable development indicators at both European and national level, and validation with the measurements of WP3 and model outputs of WP4 (Figure 8). Therefore, indicators were included in the final set if they addressed the key sustainability objectives for the city, were within the scope of BRIDGE and were measurable/modelable within the project. Moreover, where an indicator was identified at the CoP but was not measurable/modelable by BRIDGE, it was still considered valid if included in any national/regional or European indicators list. Such indicators were also included in the final set as it was considered that indicator data/values were available and thus they could be potentially gathered and assessed.

Figure 8. *Indicator validation approach.*



Indicators respond to a communication need between scientists and policy makers, enabling and/or promoting information exchange regarding the issue/s they address (EEA, 2005). This is commonly achieved by simplification of the observed reality, focussing the data choice on certain aspects which are regarded relevant and on which data are available, having a significance that goes beyond what is obtained from measured properties (Smeets and Weterings 1999). In order to be useful for decision makers, scientific data will need to be transformed into indicator data, and in some cases grouped according to a given criteria – i.e. aggregated into a simple or composite value, which allow for the identification of trends correlated to the policy action under assessment.

European Environmental Indicators and BRIDGE

The European Environment Agency (EEA) has established a core set of policy-relevant indicators in order to give answers to selected priority policy questions. These indicators address the status or progress of environmental resources in meeting the targets established in the legislation, thus facilitating environmental reporting.

The indicators in the core set have been selected from a much larger set on the basis of their relevance to policy priorities, objectives and targets, the availability of high-quality data over both time and space, and the application of well-founded methods for indicator calculation. Therefore, the EEA identifies a core set of 37 indicators for environmental reporting, in order to:

- Provide a manageable and stable basis for indicator-based assessments of progress against environmental policy priorities;
- Prioritize improvements in the quality and coverage of data flows, which will enhance comparability and certainty of information and assessments; and
- Streamline contributions to other indicator initiatives in Europe and beyond.

Of these 37 indicators, 6 apply to air pollution and ozone depletion, 4 to climate change, 5 to energy and 7 to water resources – the main aspects analysed under the scope of BRIDGE.

The policy objectives for air quality in the European Community mostly focus on the reduction of anthropogenic pollutant emissions and the increase of pollutant sinks, in order to protect human health and mitigate the effects of climate change. BRIDGE focuses on carbon and pollutants as components of the urban metabolism process. Therefore, the objective of the project is to promote sustainable land use planning, by identifying the planning alternative that maximizes the reduction of key pollutants in the atmosphere (i.e. CO_2, NOx, SO_2, PM_{10}, $PM_{2.5}$).

European Community initiatives and policies with regard to energy aim at reducing the overall energy consumption and the associated pollutant emissions through an incremental use of renewable energy sources. BRIDGE considers the energy balance in the urban system as a net heat exchange, particularly focusing on the heat island effect (exacerbated by the effects of climate change). Nevertheless, due consideration is given to energy consumption mechanisms through the assessment of planning alternatives that optimize energy efficiency in the urban structure and maximize renewable energy sources.

Several European legislations aim at reducing the loads and impacts of nutrients in water resources. However, water balance measures have only recently been put in place (e.g. flood risk management). BRIDGE looks at the water balance in urban systems, assessing the sustainability of planning alternatives on the basis of their effects on the water cycle.

Taking into account the scope of BRIDGE, the EEA indicators relating to air pollution and ozone depletion can be coupled with the indicators addressing climate change. Similarly, the energy indicators considered by the EEA can be grouped to address the overall consumption by production source and by sector. All the EEA indicators relating to water refer to nutrient load, and therefore, fall outside the scope of BRIDGE. Consequently, the EEA indicators relevant to BRIDGE are indicated in Table 2 below.

Table 2. *EEA indicators relevant to BRIDGE.*

Indicators	Specifications
AIR	
Anthropogenic emissions of acidifying substances	Emissions of nitrogen oxides – NOx, ammonia – NH_3, and sulphur dioxide – SO_2; Weighted by their acidifying potential; and Classified by sector.
Anthropogenic emissions of ozone precursors	Emissions of nitrogen oxides – NOx, carbon monoxide – CO, methane – CH_4 and non-methane volatile organic compounds – NMVOCs; Weighted their tropospheric ozone-forming potential; and Classified by sector.
Emissions of primary particulate matter	Emissions of particulate matter less than 10 µm (PM_{10}); Aggregated according to the particulate formation potential of each precursor; and Classified by source sector.
Concentrations of acidifying substances	Concentrations of nitrogen oxides – NOx, ammonia – NH_3, sulphur dioxide – SO_2; nitric acid (HNO_3) and sulphuric acid (H_2SO_4)
Trospospheric ozone concentrations	Tropospheric concentration of ozone –O_3
Particulate matter concentrations	Concentrations of particulate matter less than 10 µm (PM_{10});
Population in Europe exposed to ambient air concentrations above target values	Percentage of the urban population in Europe potentially exposed to ambient air concentrations (in µg/m3) of SO_2, NO_2 & PM_{10} in excess of the EU limit or target value set for the protection of human health.
CLIMATE CHANGE	
Anthropogenic GHG emissions	Emissions of carbon dioxide - CO_2, nitrous oxide – N_2O, and methane - CH4, and fluorinated gases (HFCs, PFCs, and SF6); All data are in million tons CO_2-equivalent; and Classified by source sector.
Annual average temperature	Annual urban average temperature and winter/summer temperatures; All compared with the 1961–1990 average; and Units are °C.
Projections of GHG emissions	Projections of carbon dioxide - CO_2, nitrous oxide – N_2O, and methane - CH4, and fluorinated gases (HFCs, PFCs, and SF6); All data are in million tons CO_2-equivalent; and Global annual averages are considered.
ENERGY	
Energy consumption by sector	Sum of final energy consumption of all sectors; Measured in thousand tons of oil equivalent; and Disaggregated into industry, transport, households, services and agriculture.
Energy consumption by fuel type	Disaggregated into fossil fuels (coal, oil, gas) and renewable sources (wind, solar, geothermal, wave/tidal, hydropower, biomass, landfill gas and biogases); Measured in thousand tons of oil equivalent; and The share of each fuel in total energy consumption is presented in the form of a percentage.

2.4 Participative Techniques

A CoP is voluntary and develops organically around people who share a concern or a passion for something they do and who deepen their knowledge and expertise in a particular area by interacting on an ongoing basis (Groot *et al.*, 2009). In the context of BRIDGE, the CoP was initiated in each case study through a kick-off meeting by inviting key stakeholders (e.g. planners, architects, consultants, researchers, etc.) and encouraging a discussion on urban sustainability. This promoted participants to identify common interests and build connections. The kick-off CoP meetings were prepared by WP2 and WP5 team members, in collaboration with the relevant case study coordinators and leaders, and differed among the 5 cities in terms of number and background of participants and the thematic areas/aspects covered. In general terms, the participative approach included a combination of techniques, including:

- Individual participation – providing individual perceptions and values through the questionnaire provided (Appendix A).
- Group participation – through presentations made by experts and interested stakeholders to facilitate open discussion, as well as through focus groups to discuss key sustainability objectives and indicators based on predetermined questions (e.g. what indicators are required to demonstrate that natural resources are protected/improved?).

The agenda of the kick-off meetings included an introduction to the BRIDGE project and to the process of developing sustainability objectives and indicators to be used in the DSS. Local participants then proceeded to describe/present key issues in the city in relation to urban planning and environmental protection. Each presentation was followed by a questions & answers session to clarify aspects and encourage debate. The afternoon session was dedicated to group work (i.e. focus groups). Participants were divided into groups to discuss and agree on sustainability principles and address each one of the BRIDGE domains (i.e. water, air, energy and socio-economic considerations). Subsequently, the groups presented their outcomes and these were recorded into meetings reports and circulated among participants after the meeting for their review and comment.

The second round of CoPs focused more on what the DSS could do to improve urban planning, and discussed the details of the planning alternatives selected for testing the DSS in each city. Local planners presented the characteristics of the plan area and the proposed alternatives, and participants were divided into two groups to:

- Review the environmental objectives and indicators proposed at the kick-off meeting and adapt them to the case study according to their relevance and applicability; and
- Review the socio-economic objectives and indicators proposed at the kick-off meeting and propose additional socio-economic indicators needed to evaluate the sustainability of proposed development alternatives.

The question used in order to assist local partners in the choice of indicators was “what criteria/indicator might help you to distinguish a good planning alternative from a bad one with regards to urban sustainability“. The objectives and indicators derived from the second round of CoPs were tailored to the assessment needs of the specific case studies (refer to Appendix C for further detail).

All objectives and indicators were reconsidered during the Umbrella CoP meeting. Representatives from each case study were brought together to share knowledge and an attempt was made to identify the principal objectives that need to be reached to achieve urban sustainability. The aim was to define the shared or common objectives and indicators which are applicable to all the case study cities and, therefore, critical in the DSS interface. The meeting consisted of an open debate around the identified issues, assisted by the following questions:

- Are the proposed objectives and indicators identical with generic sustainability aims in the local urban contexts, or specific to the planning case chosen? Can they be defined as "typical" or “common” issues encountered also in other urban areas?
- Which of the environmental and socio-economic indicators can be commonly applied to assess sustainability across Europe?
- Which indicators are most relevant or need to be prioritized? Which ones can be measured by BRIDGE? What are the key gaps (i.e. if they cannot be measure by BRIDGE, can planning alternatives be efficiently assessed)?

Participants were also asked to highlight from a list those indicators that were most relevant. Results were gathered and presented for a final review and concurrence. This allowed reaching a common agreement on key considerations and facilitated a common understanding on the aspects critically assessed in the DSS. It was made clear at this point, that the common objectives and indicators will be incorporated as defaults into the DSS but that it will not be limited to these parameters (i.e. the end-user will be able to incorporate additional objectives and indicators if applicable and if data are available).

2.5 Limitations within BRIDGE

The domain of interest of BRIDGE is sustainable urban development, to be analysed within a set of boundaries determined by the scope of the project: carbon and pollutants, energy and water. These boundaries constrain the detailed assessment of additional sustainability issues (such as mobility and human well-being identified during the CoPs). Additional limitations to the assessment of sustainable urban metabolism are posed by the availability of data in particular, but also tools and expertise.

In the light of this, the selected indicators are subject to the project’s requirements. They are verified against the selection criteria and validated to ascertain that they are applicable and can be measured and/or modeled by BRIDGE, or that are currently monitored in the relevant case studies.

Additional constraints were posed by the limited resources within BRIDGE, which restricted the consultations and debate with end-users to 2 CoP meetings in each case study city and 2 Umbrella meetings (one of which is pending and will be held later on in the project).

3. Results

3.1 Results of the Kick-off CoP Meetings

The first round of CoP meetings allowed gathering information on the relevant sustainable development aspects for the city in question (Appendix B). During these meetings, the planning priorities were established and the core sustainability objectives determined for each city. In the majority of cases, preliminary indicators were also discussed; in some of the cases these preliminary indicators were proposed by WP5 based on the established objectives. These indicators were further discussed during the second CoP meetings (Appendix C) and adjusted to the specific requirements of the planning alternatives to be analysed.

The results in Table 2 show a clear correlation among the cities in relation to some of the sustainability objectives. Air quality was considered to be one of the key objectives (with particular emphasis in reducing emissions from health-damaging contaminants such as particulate matter), followed by the need for the improvement of energy efficiency (mostly related to the bad insulation and poor energy performance of aging built infrastructure), and the mitigation of climate change effects (in relation to both temperatures increases and flooding events). A majority of the case studies also highlighted mobility and green space issues, highlighting the need to improve such aspects to promote sustainability. However, these aspects are not within the scope of BRIDGE.

Due to the existing correlation between objectives, there was also a significant overlap in the proposed indicators. In terms of air quality, key pollutant emissions and concentrations, together with their relative sectoral share, were proposed as indicators. Energy consumption and demand, as well as percentage of supply coming from renewable sources, were the most common indicators suggested to monitor energy performance. Flooding events was the most widely suggested indicator to monitor water balance; water supply and consumption were rarely viewed as issues during the CoPs.

The planning issues discussed during the first round of CoPs were generally connected to the international debate on urban sustainability issues, and are potentially common to a big range of cities. Consequently, the sustainability objectives could contribute to an international comparison of performances. These objectives commonly relate to indicators which are reflected also in international indicator sets used for cross-national assessments of urban sustainability (EEA, 2005) making the performances in case study cities comparable among each other as well as among other European cities.

Table 3. *Results of the kick-off CoP meetings.*

	AIR		ENERGY	
	Objectives	**Indicators**	**Objectives**	**Indicators**
ATHENS	**Improve Air Quality**	• Concentration of pollutants (NOx, SOx, PM_{10}, $PM_{2.5}$). • Number of days above established air quality thresholds.	**Improve Energy Efficiency**	• Energy consumption per capita. • % of energy from renewable sources.
ATHENS	**Reduce CO_2 Emissions**	• CO_2 emissions. • % of CO_2 emissions from anthropogenic sources. • Effects of meteorological conditions on concentrations.	**Reduce Thermal Discomfort**	• Average outdoor temperature (surface and air). • Average indoor temperature (particularly in old buildings).
FIRENZE	**Improve Air Quality**	• Concentration of pollutants (PM_{10}, CO_2, NO_x, SO_x, CO, etc.).	**Improve Energy Efficiency**	• Kw (or %) produced from renewable sources. • % of energy consumed (and saved) per capita. • Number of properties with passive heating. • Number of properties with insulation improvements. • Urban temperature indoors/outdoors.
GLIWICE	**Improve Air Quality**	• Concentration of pollutants (PM_{10}, CO_2, NO_x, SO_x, CO, etc.). • Contribution of 'low emissions' to the total emissions. • Energy consumption for low emission stoves (% change)	**Optimise Energy Efficiency**	• Energy loses (GJ/MW tonnes/m3/y/). • Number (%) or modernized/insulated old buildings. • Number or surface area of buildings in relation to total urban area. • Length of newly built heating systems/year. • Number of newly adjoined beneficent/year.
HELSINKI	**Improve Air Quality**	• Concentration of pollutants (O_3, NOx, SOx, PM_{10}, $PM_{2.5}$). • Total greenhouse gases and CO_2 emissions per capita and sectoral split. • Emissions from transport and split per type (private and public).	**Optimize Energy Consumption**	• Electricity consumption per capita and sectoral split. • Energy ratings and heating in buildings. • % of energy from renewable sources.
LONDON	**Improve Air Quality**	• Concentration of pollutants (Benzene, NOx, SOx, PM_{10}, $PM_{2.5}$). • Number of days above established air quality thresholds.	**Decrease Heat Island Effect**	• Average outdoor temperature (surface and air).
LONDON	**Reduce CO_2 Emissions**	• CO_2 concentration. • % of emissions from anthropogenic sources. • Effects of meteorological conditions on concentrations.		

Table 3 (cont.). Results of the kick-off CoP meetings.

	WATER		OTHERS	
	Objectives	**Indicators**	**Objectives**	**Indicators**
ATHENS			**Improve the Built Fabric**	• Building characteristics. • Number of dwellings where insulation improvements have taken place.
			Increase Green Space Areas	• Area (ha) of urban green space. • Number of trees planted. • Coverage (m^2) of green infrastructure (from new plantations and growth). • % of urban green space of total urban area.
			Increase Mobility	• Number of municipal passenger transport services. • % of population using public transport. • Number of new car-parking spaces.
FIRENZE			**Improve Mobility**	• Car ownership. • Public transport use (%).
			Increase and Improve Green Space Areas	• Number of trees/per person/hectare. • Density of green areas (m^2/capita). • Number of green roofs/green walls. • Accessibility (distance and number of public transport links). • Number of service/person/green area. • Volume of irrigation (or %) coming from rainwater.
GLIWICE	**Improve Water Mgmt.**	• Volume of water used by sector. • % of population connected to waste water treatment.	**Promote Controlled Expansion of Urban Areas**	• Number of newly elaborated land use plans. • % of surface covered by land use plans. • Daily travel time to/back from the city centre. • Number of services in the city centre. • Increases on taxation.
			Improve Mobility	• Car ownership. • Public transport use (%). • Number of new roads built. • Number of cycle-ways provided.
HELSINKI	**Protect the Water Balance**	• Water balance: precipitation, surface run-off, evapotranspiration, filtration, and flooding events. • Water quantity and quality (i.e. BOD, N, P load) at discharge point.	**Enhance human well-being in the city**	• Number of new developments in brownfield sites versus number of developments in greenfield sites; • Density of developments (persons/m^2). • Population exposure to air pollutants.

Table 3 (cont.). Results of the kick-off CoP meetings.

	WATER		OTHERS	
	Objectives	**Indicators**	**Objectives**	**Indicators**
LONDON	**Reduce Flooding**	• Flood events.	**Promote Integrated Decision-making**	• Public participation and effectiveness. • Quantitativeness of SEA/EIA/HIA reports. • Number of interdepartmental consultations. • Number of processes/aspects being studied.
LONDON			**Increase Canopy Cover**	• Number of trees planted. • Coverage (m^2) of green infrastructure (from new plantations and growth).

3.2 Results of the Second Round of CoP Meetings

The indicators proposed at the kick-off CoP meetings were reviewed to suit them to the specific assessment requirements of the relevant case study alternatives. Socio-economic and environmental indicators where separately discussed.

The specific characteristics of the case studies (refer to Appendix C for further detail) largely shaped the revised set of sustainability objectives and indicators. The implications for the green area in the Firenze case study and the regeneration plan for improving thermal comfort in Athens, significantly shaped the discussion around indicators. Similarly, the urban development alternatives considered as case studies for both Helsinki and Gliwice, specified the scope of the discussion. In all cases, the proposed indicators targeted key considerations to be assessed and monitored in order to ascertain the success/failure of those planning interventions.

From the results, it can be concluded that certain environmental and socio-economic considerations remain common to all the cities. These include improving air quality (and the associated concentration and distribution of pollutants as indicators), improving energy efficiency (with energy demand/consumption and percentage of renewable energy sources as indicators) and ensuring social inclusion/comfort (with use/appreciation of services and social composition as key indicators). It is anticipated that these objectives and indicators will be part of the final set of common indicators, which will be discussed and agreed at the Umbrella CoP meeting.

It is worth noting that the indicators defined in the second round of CoPs are only able to consider some of the generic and long term sustainability objectives defined at the city level in the previous round of CoPs, given the more limited range and scale of the spatial and sectoral plans proposed as case studies. Therefore, these indicators will not allow for comparability across case studies, as planning problems identified are not similar among the case studies, neither in scale nor in kind, and so also trends and values observed will vary between the single applications. Nevertheless, the indicators identified at this level may contribute to the building up of an operative indicator set for planning with urban metabolism, where record is kept on type of measurements used, composition of data in case of composite indicators, data availability etc.

In some of the CoP meetings, an attempt was made to prioritise indicators according to their level of importance/significance. Due to time constraints, this was solely achieved in Gliwice (refer to Appendix C for further detail). In London it was proposed that indicators should be prioritised according to the number of issues they address (e.g. the number of trees planted can address green canopy cover, carbon sequestration, shading and cooling, air quality and water balance issues).

Table 4. *Results of the second CoP meetings for environmental objectives and indicators.*

	ENVIRONMENTAL	
	Objectives	**Indicators**
ATHENS	**Reduce Thermal Discomfort**	• Average outdoor temperature (air) and humidity; • Average surface temperature (roads, buildings, etc.); and • Wind speed.
	Improve Air Quality and Reduce Emissions	• Concentration of pollutants (NOx, SOx, PM_{10}, $PM_{2.5}$); • CO_2 emissions; • Source of emissions (% per building/sector type); • Number of days above established air quality thresholds; and • Effects of meteorological conditions (e.g. temperature) on concentrations.
	Increase Green Space Areas	• Area (% or m^2) of urban green space; • Number of trees planted; and • Types of trees planted.
	Optimize Water Use	• Volume of water used (for irrigation).
	Improve Energy Efficiency	• Energy consumption for lighting the avenue; and • % of energy from renewable sources (i.e. solar panels).
	Optimize Quality of Materials Used	• Solar reflectance of materials used.
FIRENZE	**Improve Energy Efficiency**	• Urban temperature outdoors (compared to rural temperatures), and • Potential renewable energy from the volume of biomass produced.
	Increase and Improve Green Space Areas	• Number of trees/per person/hectare (and number of trees planted); • Density of green areas (m^2/inhabitant); • Accessibility (distance by foot/bike, and number of public transport links); • Number of services per person in the green area; and • Biodiversity (plant species, pollen season, etc.)
	Improve Air Quality	• Concentration of pollutants (PM_{10}, $PM_{2.5}$, NOx, CO).
GLIWICE	**Improve Air Quality**	• Spatial distribution of pollutants (PM_{10}, $PM_{2.5}$, NOx, SOx, CO, CO_2); • Contribution of 'low emissions' (from single boilers located in the low residential dwellings) to the total emissions; • Total emissions (% change); and • Relationship between pollutant concentrations and wind direction.
	Improve Energy Efficiency	• Energy demand (kW/h/m^2 or % change); • Heating demand (kW/h/m^2 or % change); and • % and structure of thermo-insulation.

Table 4 (cont.). Results of the second CoP meetings for environmental objectives and indicators.

	ENVIRONMENTAL	
	Objectives	**Indicators**
GLIWICE	**Improve Water Management**	• Urban water use; • Urban water supply; • % of waste water treated; • River capacity (both quality – BOD, and quantity - volume); • WFD quality values; • % of "solid" area (and % of change); • Flooding zones; • Sewage capacity (volume); • % of houses connected to the WWT; and • Volume of discharge.
HELSINKI	**Optimise Energy Consumption**	• Energy demand (i.e. electricity consumption per dwelling); • Energy balance in buildings (i.e. energy heating); and • Percentage of energy from renewable sources.
HELSINKI	**Protect the Water Balance**	• Water balance: surface run-off, evapotranspiration, and filtration.
HELSINKI	**Improve Air Quality**	• Concentration of pollutants (ozone and particulate matter); • Greenhouse gases and CO_2 emissions per capita; and • Emissions from transport and split per type (private and public).
HELSINKI	**Enhance Human Well-being**	• Density of developments (persons/m^2); and • Population exposure to air pollutants.
HELSINKI	**Anticipating Climate Change**	• Carbon intake (i.e. removal of carbon sinks); • Material reuse (e.g. soils); and • Number of zero-carbon buildings.
LONDON	**Improve Air Quality**	• Concentrations of PM_{10}, $PM_{2.5}$, NOx, NO_2 and O_3; and • Number of days above established air quality thresholds.
LONDON	**Reduce Surface Water Flood Risk**	• Number and extension of "hot spots".
LONDON	**Mitigate Heat Islands Effect**	• Ambient temperature (at 1m above street level); and • Number of days above 33°C /per area ("heat waves").
LONDON	**Decentralize Energy Generation**	• % of energy created; and • Additional heat generated.
LONDON	**Increase Urban Greening**	• Canopy surface newly created; and • Accessibility to green areas.

Table 5. Results of the second CoP meetings for socio-economic objectives and indicators.

City	SOCIO-ECONOMIC Objectives	Indicators
ATHENS	**Improve Mobility**	• Road traffic intensity; • Quality of pedestrian sideways; and • Number of parking slots.
ATHENS	**Maintain Public Health and Safety**	• Number and severity of road accidents and pedestrian injuries; • Number of people suffering from short term effect of air pollution (upper respiratory infections such as bronchitis and pneumonia, allergic reactions); and • Number of people suffering from long term effects of air pollution (e.g. chronic respiratory disease, lung cancer, heart disease).
ATHENS	**Promote Social Inclusion**	• Extent to which roads and sideways can be used by disabled or differently able people and groups (e.g. number of safe-street-crossing points, number of repose places along the street); and • Local community composition – compared to other areas: % of elderly people, foreigners, low-income families etc.
ATHENS	**Promote Place Identity**	• Aesthetic value of the area and changes due to planning intervention.
ATHENS	**Ensure Economic Viability**	• Financial costs of the interventions; and • Estimated side-effects on local economy.
FIRENZE	**Promote Social Comfort**	• Usability of the park (number, time and type of uses); • Public appreciation of the park; • Increase/decrease on public parking spaces; and • Number of illegal activities (crime events).
FIRENZE	**Ensure Economic Viability**	• Cost associated to maintenance and pruning; and • Benefits perceived by private economic activities
GLIWICE	**Improve Mobility**	• Number of pedestrian streets (Km); • Public transport use (%); • Length of new roads built (Km); • Length of cycle-ways provided (Km); and • Number of parking places built up.
GLIWICE	**Controlled Expansion of Urban Areas**	• Number of administrative decisions; • Accessibility of district from Silesia metropolitan area (hours to/from); • Number of specific services in the district; • % of new public space; and • Increase on incomes.
HELSINKI	**Cater for Housing Demand**	• Number and type of dwellings; • Population growth; • Demand for housing types; and • Percentage of owned/rented dwellings.
HELSINKI	**Promote Social Inclusion**	• Access to housing; • Social class/ethnical group; • Age group of residents; and • Number of family households.
HELSINKI	**Optimise Accessibility**	• Travel time to work; and • Use of public transport.
LONDON	**Improve Human Well-being**	• Number of health impacts derived from “heat waves” and air pollution; and • Number of residents affected by flash flooding.
LONDON	**Ensure Economic Viability**	• Cost of maintenance of green areas; • Cost of drainage; and • Value at risk of flooding.

The following tables illustrate how the relevant indicators evolved during the first and second CoP. The indicators that were amended or proposed as new in the second round of CoP meetings are highlighted in *italics*. It can be concluded that the concerns of participants were maintained as the indicators address the same or similar issues at both city and project level, although certain aspects (e.g. water balance in Gliwice or social inclusion in Helsinki) were raised as a result of specific considerations associated with the planning alternatives. Note also that certain indicators were considered irrelevant for assessing the planning alternatives at project level (e.g. % of emissions from anthropogenic sources in London) and were, therefore, removed from the indicators list (refer to Tables 4 and 5 for further detail).

Table 6. *Comparative results of environmental indicators between first and second CoP meetings.*

City	ENVIRONMENTAL INDICATORS
ATHENS	**AIR QUALITY**
ATHENS	• Concentration of pollutants (NOx, SOx, PM_{10}, $PM_{2.5}$); • CO_2 emissions; • Number of days above established air quality thresholds; • Effects of meteorological conditions (e.g. temperature) on concentrations; and • *Source of emissions (% per building/sector type).*
ATHENS	**ENERGY**
ATHENS	• Energy consumption *for lighting the avenue*; • % of energy from renewable sources (*i.e. solar panels*); • Average outdoor temperature (air) *and humidity*; • Average *surface temperature (roads, buildings*, etc.); and • *Wind speed.*
ATHENS	**WATER**
ATHENS	• *Volume of water used (for irrigation).*
ATHENS	**OTHERS**
ATHENS	• Solar reflectance of materials used.
FIRENZE	**AIR QUALITY**
FIRENZE	• Concentration of pollutants (PM_{10}, $PM_{2.5}$, NOx, CO).
FIRENZE	**ENERGY**
FIRENZE	• Urban temperature outdoors (*compared to rural temperatures*), and • *Potential renewable energy from the volume of biomass produced.*
FIRENZE	**OTHERS**
FIRENZE	• Number of trees/per person/hectare (*and number of trees planted*); • Density of green areas (m^2/inhabitant); • Accessibility (distance *by foot/bike*, and number of public transport links); • Number of services per person in the green area; and • *Biodiversity (plant species, pollen season, etc.).*
GLIWICE	**AIR QUALITY**
GLIWICE	• Distribution of pollutants (PM_{10}, *$PM_{2.5}$*, NOx, SOx, CO, CO_2); • Contribution of ‘low emissions’ (*from single boilers*) to the total emissions; • *Total emissions (% change);* and • *Relationship between pollutant concentrations and wind direction.*

Table 6 (cont).Comparative results of environmental indicators between first and second CoP meetings.

City	Indicators
GLIWICE	**ENERGY**
	• *Energy demand (kW/h/m^2 or % change);* • *Heating demand (kW/h/m^2 or % change);* and • *% and structure of thermo-insulation.*
	WATER
	• Urban water use (volume); • *Urban water supply;* • *% of waste water treated;* • *River capacity (both quality – BOD, and quantity - volume);* • *WFD quality values;* • *% of "solid" area (and % of change);* • *Flooding zones;* • *Sewage capacity (volume);* • % of houses connected to the WWT; and • *Volume of discharge.*
HELSINKI	**AIR QUALITY**
	• Concentration of pollutants (*ozone and particulate matter*); • Greenhouse gases and CO_2 emissions per capita; • Emissions from transport and split per type (private and public).
	ENERGY
	• Energy demand (i.e. *electricity consumption per dwelling*); • *Energy balance in buildings (i.e. energy heating)*; and • Percentage of energy from renewable sources.
	WATER
	• Water balance: surface run-off, evapotranspiration, and filtration.
	OTHERS
	• Population exposure to air pollutants; • *Carbon intake (i.e. removal of carbon sinks);* • *Material reuse (e.g. soils);* and • *Number of zero-carbon buildings*.
LONDON	**AIR QUALITY**
	• Concentration of pollutants (NO_2, NOx, PM_{10}, $PM_{2.5}$, O_3,); and • Number of days above established air quality thresholds.
	ENERGY
	• *% of energy created; and* • *Additional heat generated;* • *Ambient temperature (at 1m above street level);* and • *Number of days above 33°C /per area ("heat waves").*
	WATER
	• *Number and extension of "hot spots".*
	OTHERS
	• Coverage (m^2) of green infrastructure (from new plantations and growth); and • *Accessibility to green areas*.

Table 7.*Comparative results of socio-economic indicators between first and second CoP meetings.*

	SOCIO-ECONOMIC INDICATORS
	SOCIAL
ATHENS	• *Road traffic intensity;* • *Quality of pedestrian sideways;* • *Number of parking slots;* • *Number and severity of road accidents and pedestrian injuries;* • *Number of people suffering from short term effect of air pollution (upper respiratory infections such as bronchitis and pneumonia, allergic reactions);* • *Number of people suffering from long term effects of air pollution (e.g. chronic respiratory disease, lung cancer, heart disease);* • *Extent to which roads and sideways can be used by disabled or differently able people and groups (e.g. number of safe-street-crossing points, number of repose places along the street);* • *Local community composition – compared to other areas: % of elderly people, foreigners, low-income families etc.;* and • *Aesthetic value of the area and changes due to planning intervention.*
	ECONOMIC
	• *Financial costs of the interventions*; and • *Estimated side-effects on local economy*
	SOCIAL
FIRENZE	• Usability of the park (number, time and type of uses); • Public appreciation of the park; • Increase/decrease on public parking spaces; and • Number of illegal activities (crime events).
	ECONOMIC
	• Cost associated to maintenance and pruning; and • Benefits perceived by private economic activities.
	SOCIAL
GLIWICE	• *Number of pedestrian streets (Km);* • *Public transport use (%);* • *Length of new roads built (Km);* • *Length of cycle-ways provided (Km);* • *Number of parking places built up*; • Number of administrative decisions; • Accessibility of district *from Silesia metropolitan area (hours to/from);* • Number of *specific* services *in the district;* • *% of new public space*; and • Increase on *incomes*.

Table 7 (cont).Comparative results of socio-economic indicators between first and second CoP meetings.

HELSINKI	**SOCIAL**
	• *Number and type of dwellings;* • *Population growth;* • *Demand for housing types;* • *Percentage of owned/rented dwellings;* • *Access to housing;* • *Social class/ethnical group;* • *Age group of residents;* • *Number of family households;* • *Travel time to work*; • *Use of public transport*; and • Density of developments (persons/m^2).
LONDON	**SOCIAL**
	• *Number of health impacts derived from "heat waves" and air pollution; and* • *Number of residents affected by flash flooding.*
	ECONOMIC
	• *Cost of maintenance of green areas;* • *Cost of drainage;* and • *Value at risk of flooding.*

3.3 Results of the Umbrella CoP

The indicators proposed at the individual CoP meetings were reviewed based on the selection criteria, mainly in terms of their applicability and data availability, and validated before being proposed as final indicators for BRIDGE. These were consequently presented as a starting point for discussion at the Umbrella CoP.

The objectives and indicators were, therefore, subject to review by case study representatives. The overview of planning and sustainability issues in each of the cities and the shared understanding of sustainability goals facilitated the identification of the common and most critical objectives across all the cities. The results correlate with the findings of the first and second CoP meetings. Those sustainability objectives identified in each city (i.e. improving air quality and energy efficiency and optimising water balance, including the reduction of flooding effects) were perceived as being critical in promoting overall sustainable urban development. There was consensus among participants for the incorporation of such considerations together with relevant indicators into the final indicator set and, subsequently, the DSS. The rest of relevant objectives and associated indicators were classified as secondary, not for their lack of significance but rather for their city-specific nature. Thermal comfort was not considered an issue in either Firenze or Gliwice; the type of materials used was deemed irrelevant in Firenze and London and green spaces were not a priority in either Helsinki or Gliwice. Therefore, it was proposed that these city-specific (or discretionary) objectives would not be readily available in the DSS. Nevertheless, the end-user would be able to incorporate them if deemed appropriate.

Although consensus was also reached when defining the core socio-economic objectives, certain indicators (e.g. the length of roads associated with mobility) were subject to lengthy debate as a result of the differing planning and development approaches between the case study cities. In all cases, it was perceived that the economic viability of the planning interventions represented a critical factor in the assessment. Similarly, changes in land use patterns and mobility were considered crucial sustainability considerations. Social inclusion was considered highly relevant in both London and Athens, while human well-being combined with health/safety were also relevant in all the cities. Despite the project's limitations (Section 2.5), these socio-economic considerations will be included in the final set of indicators and accordingly integrated into the DSS, where the end-user will be prompted to provide relevant data.

Table 8. *Results of the Umbrella CoP meetings.*

ENVIRONMENTAL	
Objectives	**Indicators**
Common Aspects (Core)	
Improve Air Quality	• Concentration of pollutants (PM_{10} and $PM_{2.5}$, O_3, NOx) • GHG and CO_2 emissions • Number of days above established air quality threshold
Improve Energy Efficiency	• Energy demand (kw per hour per m^2) • Potential for renewable energy • Additional heat generated • % of energy created (renewables)
Anticipate CC (Flooding)	• Flooding zones (m^2) & hot spots
Optimize Water Use & Mgmt	• Surface runoff evapotransporation and filtration • Water consumption per capita
City-Specific Aspects (Discretionary)	
Increase Green Space Areas	• Density of green areas (m^2 per habitant) • Canopy/green surface or area newly created • Accessibility to green areas
Thermal comfort	• Ambient & surface air temperature (^oC) • Number of days above established threshold
Optimize Materials Used	• Volume of material re-used
SOCIO-ECONOMIC	
Objectives	**Indicators**
Common Aspects (Core)	
Urban land use	• New urbanized areas (land use changes) • Number of brownfields re-used • Density of development
Ensure Economic Viability	• Cost of intervention • Effects on local economy
Improve Mobility & accessibility	• Quality of pedestrian sideways • Length of cycleways provided • Length of new roads provided • Use of public transport • Number of persons close to public transport
City-Specific Aspects (Discretionary)	
Promote Social Inclusion	• Access to housing and services
Maintain Public Health/Safety Enhance Human Well-being	• Number of persons affected by flash flooding • Number of persons affected by heat waves & air pollution

4. Conclusion

4.1 Overall Findings

The participative approach allowed insight into the case study cities be gained in relation to both planning structures and issues, and sustainability considerations. The bottom-up approach adopted in BRIDGE has helped to provide the end users perspective to the research team, with the likely outcome that the DSS responds to the sustainability objectives and indicators in each city, as well as the specific needs of end-users. However, the outcomes of the CoP meetings and, as a result, the identified objectives and indicators, were largely shaped by the professional background and personal perceptions of the case study representatives. This was clearly observed in the key issues and concerns that arose during the first and second CoP meetings. Although some of the differing aspects related to the context (i.e. city versus case-specific considerations), the participation of representatives solely from certain sectors (e.g. water) in one of the meetings resulted in less emphasis being placed on other aspects. It is also considered that the limited participation of urban planners in these meetings represented a key limitation to the project.

The meetings facilitated the exploration of commonalities and divergences between the case study cities. The identification of specific planning interventions allowed further definition of sustainability objectives and indicators. In all cases, air quality, energy efficiency and water balance were considered critical sustainability considerations. Additional concerns in some of the cities included thermal comfort and green spaces. From the socio-economic perspective, land use changes, financial cost of the intervention and mobility were considered to be critical factors in all cities, together with human well-being and social inclusion in certain cities.

The agreement reached at the Umbrella CoP meeting on the core (i.e. common) and discretionary (i.e. case-specific) sustainability objectives and indicators contextualised and prioritised issues. This consistent set will facilitate the incorporation of critical considerations into the DSS.

4.2 Next Steps

The environmental and socio-economic indicators defined through the CoP meetings are to be validated (section 2.3) and operationalised (in terms of their wording and measurement units) before incorporating them in the final set. This set will be incorporated as default options into the DSS for the assessment of planning interventions.

APPENDIX A – Kick-off CoP Questionnaire

Questionnaire

BRIDGE Community of Practice

This questionnaire provides a context for discussion on key strengths, weaknesses, pressures and challenges of urban planning in Helsinki, as well as the definition of objectives and the development of indicators, during the BRIDGE CoP kick-off meeting. For further information, please contact Dr. Ainhoa González at agonzal@tcd.ie

DEVELOPMENT OF OBJECTIVES

Q1. What planning component would you prioritise (e.g. transport, services, social housing, amenity, etc.) when formulating an urban development plan for Helsinki? Why? ________________

Q2. What do you consider to be the key strengths, weaknesses, pressures and challenges in the development of the city with regards to environmental and socio-economic aspects?

	Strengths	*Weaknesses*	*Pressures*	*Challenges*
Environment				
Society				
Economy				

Comments ________________

Q3. What are the existing and/or proposed policies and objectives relating to sustainability in the Development Plan for Helsinki city and its environs? ________________

In your view, what is the most important sustainable urban development objective? Why?

Q4. What is the key barrier to achieving sustainable development in Helsinki? What is the key facilitator of sustainability in the city? Please select from below and provide comments.

Energy	Water	Emissions	Others
- Supply	- Supply	- Air (CO_2, greenhouse gases)	-
- Efficiency	- Treatment	- Water (sewage, spillages)	-
- Reliability	- Flooding	- Soils (contaminating land uses)	-

Comments ____

____

____

DEVELOPMENT OF INDICATORS

Q5. What are the most useful indicators to monitor the achievement of the sustainability objective(s) set out in Q3? Could you link these to specific criteria (i.e. targets)?

Indicators	Criteria
______________	______________
______________	______________
______________	______________
______________	______________
______________	______________

Q6. What data are currently available in your organisations to support the indicators suggested in Q5?

____

____

____

____

Are these data collected on a regular basis? ______________________________

____

____

Q7. What information do you require in order to prepare development plans in a more sustainable way?

____

____

____

Q8. What additional information could the BRIDGE project provide your organisation with in order to create more sustainable plans? ______________________________

____

____

Thank you for your collaboration

APPENDIX B – Results of Kick-off CoP Meetings

Helsinki, Finland – 15th June 2009

Introduction and Context

The meeting at the University of Helsinki brought together a group of 20 people including urban planners, an urban forester researcher, an air protection expert, and of which 12 were BRIDGE researchers. The meeting had the following objectives:

- To share experience on sustainable urban planning in Helsinki between urban planners and researchers in the field of urban metabolism;
- To build a network, i.e. Community of Practice on sustainable urban planning in Helsinki; and
- To discuss priorities in urban planning in the city of Helsinki, urban planning objectives and indicators.

As the meeting was a first gathering between BRIDGE researchers and professionals in the field of urban planning, relatively much time was planned to get to know each others' perceptions on the urban planning practices in Helsinki from a sustainability point of view – through Mr. Alpo Tani's presentation on 'Sustainable Urban Planning' in Helsinki and the walking tour in Kumpula-Arabianranta area. The walking tour enabled the participants to make explicit and/or find out about strengths and weaknesses in the current planning practices from a sustainability perspective. Moreover, it helped to discuss a number of challenges for a more sustainable planning in Helsinki.

Planning Priorities and Sustainable Planning Objectives

The open discussion in the afternoon session allowed participants to establish the planning priorities in Helsinki, which include: housing, public transport and energy sources. Based on these priorities, the core sustainability objectives were established for the city by the participants. These objectives can be summarized as follows:

- ***Optimize energy consumption***: save energy and increase use of renewable energy sources.
- ***Protect the water balance***: manage storm water to minimize flooding and to avoid water pollution through untreated surface runoff.
- ***Improve air quality***: minimize emissions and, particularly, reduce CO_2 emissions to mitigate climate change.
- ***Enhance human well-being in the city***: improve attractiveness of housing, promote a spatial balance, and improve the public transport system.

Preliminary Indicators

Taking into account the availability of data (as per Kimmo Kurumaki´s presentation in the morning session) and the urban metabolism components of BRIDGE, the following preliminary indicators were suggested by WP5 to monitor progress towards the established objectives:

BRIDGE Component	Indicators
Energy	• Energy demand (i.e. electricity consumption per capita and sectoral split: households, industry, transport and services); • Energy balance in buildings (i.e. energy ratings and heating); and • Percentage of energy from renewable sources.
Water	• Water balance: precipitation, surface run-off, evapotranspiration, filtration, and flooding events; and • Water quantity and quality (i.e. BOD, N, P load) at discharge point.
Air Quality	• Concentration of pollutants (methane, ozone, sulfates, nitrates, particulate matter, etc.); • Greenhouse gases and CO_2 emissions per capita and sectoral split: households, industry, transport and services); and • Emissions from transport and split per type (private and public).
Human Well-being	• Number of new developments in brownfield sites versus number of developments in greenfield sites; • Density of developments (persons/m^2); and • Population exposure to air pollutants.

Potential Case Study

The Honkasuo area was proposed as a test ground to assess planning alternatives with the use of the indicators. The city planners were to provide the adopted plan and propose a number of development alternatives for the area before the second CoP.

London, United Kingdom – 25th August 2009

Introduction and Context

The first CoP meeting was convened in the Department of Geography, King's College London. The 25 participants included 15 BRIDGE researchers, and academics, planners and other stakeholders with interests that spanned: sustainable urban planning, transportation and air quality, urban vegetation and London rivers.

The initial meeting served two purposes. The first was to enable the BRIDGE partners and London planners to get to know each other and through a number of talks to identify key issues of sustainable development in London. Second, through group discussion, to identify London's:

- Planning priorities, sustainability objectives and indicators with which to assess progress towards sustainable development;
- To select a London case study on which to demonstrate the DSS.

An overview of the current urban issues was presented by Mr. Alex Nickson, Strategy Manager for the Greater London Authority (such as rising of population, poverty, south east water stress, climate change, the age of London's water system, the issues associated with large areas of brownfields, etc.) followed by Mr. Charles Buckingham, Transport for London (with regards to congestion, public transport and alternative ways of transport – i.e. cycling and safety). Jim Smith, London Tree & Woodland Framework Manager, Forestry Commission described the positive roles of vegetation in the city such as the cooling effect and pollutant reduction, and Jo Heisse, Technical Officer in SE Thames Environment Agency, presented the London river action plan.

Planning Priorities and Sustainable Planning Objectives

The group exercise and open discussion in the afternoon session allowed participants to establish the planning priorities in London, which include: economic development (quality of life and employment opportunities), green infrastructure, transport, provision of infrastructure (water, energy and waste management) and climate change adaptation. The key environmental, social and economic issues associated with these planning priorities were defined as follows:

Environmental	Social	Economic
Economic Development		
There is a need to: • Promote sustainability (sustainable planning). • Adapt to climate change.	There is a need to: • Provide new and better employment. • Provide more affordable housing.	There is a need to: • Integrate planning. • Provide for continuous investment. • Reduce carbon costs.
Green Infrastructure		
There is a need to: • Plant more vegetation to act as carbon sinks. • Maximise green areas.	There is a need to: • Provide healthy landscapes.	
Transport		
There is a need to: • Reduce emissions and noise from traffic.	There is a need to: • Improve the quality of journey to work (connectivity & safety). • Reduce social exclusion (from service charge). • Remove physical barriers.	
Provision of Infrastructure		
There is a need to: • Reduce water leakage. • Reduce energy consumption and improve energy efficiency. • Improve water quality.	There is a need to: • Reduce congestion.	There is a need to: • Reduce costs from deficient infrastructure. • Assess the effects of decentralized energy infrastructure.
Climate Change		
There is a need to: • Control flooding. • Avoid draughts. • Improve air quality.	There is a need to: • Reduce heat waves (heat island effect).	There is a need to: • Reduce carbon costs; • Improve infrastructure • efficiency; • Integrate planning

Based on the above priorities and issues, the core sustainability objectives for the city were discussed and agreed by the participants. These objectives can be summarized as follows (presented in order of preference according to the participants voting results):

- ***Integrated decision-making***: promote communication channels between departments/organizations for informed and joint decision-making.
- ***Reduce CO_2 emissions***: improve energy efficiency and reduce consumption, improve public transport efficiency, and promote C-neutral land uses to reduce emissions. *London has a target of reducing concentrations - 60% by 2025*.
- ***Increase canopy cover***: Maximise the potential of green infrastructure with planting schemes and new sustainable urban designs.
- ***Improve air quality***: minimize emissions, particularly from NOx, SOx, PM_{10}, $PM_{2.5}$, Benzene and other aromatic compounds.
- ***Decrease heat islands:*** Reduce the effects of urban heat islands.
- ***Reduce flooding and climate change effects:*** Optimise infrastructure to reduce flood events and provide infrastructure and services to adapt to climate change (cooling units, hospital assistance, etc.).

Participants were informed that these objectives will be used to determine sustainability criteria (mainly based on European Directives and requirements) and indicators.

Preliminary Indicators

Taking into account the preferences established in the previous session, the following preliminary indicators were suggested by participants to monitor progress towards the established objectives:

Sustainability Objectives	Indicators
Integrated Decision-Making	• Public participation and effectiveness; • Quantitativeness of SEA/EIA/HIA reports; • Number of interdepartmental consultations; and • Number of processes/aspects being studied.
Improve Air Quality	• Concentration of pollutants (NOx, SOx, PM_{10}, $PM_{2.5}$, Benzene, etc.); and • Number of days above established air quality thresholds.
Reduce CO_2 emissions	• Total CO_2 emissions; • % of emissions from anthropogenic sources: transport, industry, households; and • Effects of meteorological conditions (e.g. temperature) on concentrations.
Increase Canopy Cover	• Number of trees planted; and • Coverage (m^2) of green infrastructure (from new plantations and growth). (*Data available from GIGL*).

Potential Case Study

The most likely case study would be based on one of the 21 opportunity areas in London which are due to be implemented in the next three years. Possible sites included the development at Vauxhall/Nine-Elms or the areas developed as part of the Olympic legacy.

Athens, Greece – 8th October 2009

Introduction and Context

The meeting was held at the Municipality of Egaleo. The 51 participants included 8 BRIDGE researchers, and urban planners, architects engineers and researchers all interested in sustainable urban planning.

The meeting was attended and launched by Mr. D. Kalogeropoulos, Mayor of Egaleo. Subsequently Mr. T. Kardomateas, Head of technical services of the Prefecture of Athens, presented the major issues faced by the municipality (mainly associated with environmental degradation due to increased urbanisation, the fires that since 1970 have reduced green spaces around Athens, the inability of the government to maintain large open spaces, and other socio-economic considerations). Professor Mateos Santamouris, from the National and Kapodistrian University of Athens, discussed the relationship between economy, energy and environment, and Miss. Fotini Xyrafi, Architect Engineer, presented the design of the Thivon Avenue, the case study area for Athens.

Planning Priorities and Sustainable Planning Objectives

The open discussion in the afternoon session allowed participants to establish the planning priorities in Athens, assisted by the aspects highlighted during the morning presentations. The planning priorities for the city include: transport (particularly due to the issues associated with poor public transportation and limited car-parking spaces, as well as air quality problems), quality of building stock (very old developments with poor insulation and poor foundations), thermal discomfort (heat-island effect: indoor/outdoor overheating during the summer months, exacerbated by climate change), and energy (high energy use for cooling).
Based on the above priorities and issues, the core sustainability objectives for the city were discussed and agreed by the participants. These objectives can be summarized as follows:

- ***Improve air quality:*** minimize emissions, particularly from NOx, and PM_{10}.
- ***Improve energy efficiency:*** and reduce consumption; improve insulation in old buildings; promote the use of solar energy.
- ***Reduce CO_2 emissions***: improve public transport efficiency and reduce private-car dependency (which will also result in reduced noise levels).
- ***Reduce thermal discomfort***: mitigate heat-island effect through planting and shadding; apply bioclimatic building materials and improve insulation of old buildings.
- ***Improve the built fabric:*** renew old buildings to incorporate insulation and improve their energy efficiency; apply bioclimatic materials in new developments (residential buildings and infrastructure).
- ***Increase green space areas:*** new parks, tree planting on streets and roof-gardens (where feasible).
- ***Improve mobility:*** improve public transport efficiency, enhance the capacity of existing roads and provide for car-parking spaces at appropriate locations.

Preliminary Indicators

Indicators were not discussed at the CoP meeting due to time constraints. However, the urban indicators currently being measured in Athens were presented by Alexandros Karvounis. Taking these and the objectives established during the afternoon discussion into account, the following preliminary indicators are proposed:

Sustainability Objectives	Indicators
Improve Air Quality	• Concentration of pollutants (NOx, SOx, PM_{10}, $PM_{2.5}$, etc.); and • Number of days above established air quality thresholds.
Improve Energy Efficiency	• Energy consumption per capita; and • % of energy from renewable sources.
Reduce CO_2 emissions	• Total CO_2 emissions; • % of CO_2 emissions from anthropogenic sources: transport, industry, households; and • Effects of meteorological conditions (e.g. temperature) on concentrations.

Reduce Thermal Discomfort	• Average outdoor temperature (surface and air); and • Average indoor temperature (particularly in old buildings).
Improve the Built Fabric	• Building characteristics; and • Number of dwellings where insulation improvements have taken place.
Increase Green Space Areas	• Area (ha) of urban green space; • Number of trees planted; • Coverage (m^2) of green infrastructure (from new plantations and growth); and • % of urban green space of total urban area.
Increase Mobility	• Number of municipal passenger transport services; • % of population using public transport; and • Number of new car-parking spaces.

Potential Case Study
The real life project in Athens will comprise the assessment of alternatives for the regeneration of the Thivon Avenue in the municipality of Egaleo.

Firenze, Italy – 16th October 2009

Introduction and Context
The meeting was held at the Osservatorio Ximeniano and gathered 17 participants, including 9 BRIDGE researchers, and academics, planners and other stakeholders with interests that spanned: Agenda 21, sustainable urban planning, air quality, and urban vegetation.

Mr. Ricardo Pozzi presented the Agenda 21 and research initiatives in the city and provided a summary of relevant guidance and manuals for monitoring environmental indicators. Mr. Alberto Giuntoli addressed the management of green spaces in the city.

Planning Priorities and Sustainable Planning Objectives
The afternoon session allowed participants to discuss and analyse the planning priorities in Firenze, which were somehow defined by the morning presentations. The planning priorities for the city include: transport (due to the issues associated with congestion and air quality problems), green spaces (due to the existence of many historical gardens with specific maintenance requirements, and to the uneven accessibility to open green areas) and energy (issues relating to both energy consumption and efficiency).

Based on the above priorities and issues, the core sustainability objectives for the city – according to each individual – were presented, discussed and agreed by the participants. These objectives can be summarized as follows:

- ***Improve mobility:*** improve public transport services and efficiency; reduce private-car dependency; minimize through traffic; and provide safe cycle-ways.
- ***Improve energy efficiency:*** and reduce consumption; improve insulation in old buildings (especially windows); promote the use of solar energy and other renewable sources; use better building materials.
- ***Increase green space areas:*** and improve their management; create a network of green areas; provide new open spaces; provide additional tree planting on streets and open spaces; create green roofs/walls (where feasible); enhance public services in green areas and improve maintenance practices.

- ***Improve air quality:*** minimize emissions, particularly dust (PM_{10}) and CO_2 but also NOx, SOx, and CO; and reduce humidity (through more efficient public transport systems, reduced private-car use, and tree planting).

Preliminary Indicators

Indicators were proposed by participants, linked to the objectives for the city, which were as follows:

Note that the indicators are preliminary only. These will be validated with the Agenda 21 sustainability indicators available for the Toscana region and the Firenze area. They will also be further discussed at the second Community of Practice meeting and contextualized to the BRIDGE components (i.e. water, air quality and energy). Note that the availability of data for the proposed indicators was not explored due to time constraints.

Sustainability Objectives	Indicators
Improve Mobility	• Car ownership. • Public transport use (%).
Improve Energy Efficiency	• Kw (or %) produced from renewable sources (solar panels and biofuels in particular). • % of energy consumed (and saved) per capita. • Number of properties fitted with passive heating. • Number of properties where insulation improvement has taken place. • Urban temperature indoors/outdoors (compared to rural temperatures).
Increase and Improve Green Space Areas	• Number of trees/per person/hectare (and number of trees planted). • Density of green areas (m^2/capita). • Number of green roofs/green walls. • Accessibility (distance and number of public transport links). • Number of services per person in the green area. • Volume of irrigation (or %) coming from rainwater.
Improve Air Quality	• Concentration of pollutants (PM_{10}, CO_2, NOx, SOx, CO, etc.).

Potential Case Study

A number of potential case studies were discussed, including:

- Replacement of 40% of mature street trees throughout the city.
- Castello Park – 140 hectares, 80 of which are planned to be a public urban park. The park is controversial and on hold at the moment: the design doesn't match the Regulations with regards to species and biodiversity.
- Cascine Park – Existing park where many trees have to be cut; the effects of pruning, felling and replanting trees or changing some species on the quality of air could be analyzed.
- Violet city – a new stadium for the local football team and the area around it. The old stadium is too close to the city centre and not accessible for cars.

Cascine was suggested as the most suitable option.. A significant amount of information is available for this existing park, which is in need of regeneration. Therefore, the assessment could address the effects of a number of alternatives for Cascine Park, such as pruning and/or felling of a number of trees and their replacement with varied tree species.

Gliwice, Poland – 20th October 2009

Introduction and Context

The meeting was held at the city hall, where 24 participants – 4 BRIDGE researchers, and 20 local planners and stakeholders gathered to discuss the planning priorities and sustainability issues in the city. The stakeholders' interests mostly focused on urban planning, environmental protection, air quality and water management.

Mrs. Katarzyna Kobierska, Head of Bureau of City Development at the City Hall, addressed sustainable urban planning in Gliwice. Mrs. Małgorzata Knebloch, from Department of Urban Planning, presented the planning system and Mr. Tomasz Misztal, from the Department of Environment, described metereological conditions and air quality issues in the region. Mr. Paweł Filipiak, from the Independent Department of Municipal Spatial Information System, described existing spatial datasets and their use; while Mr. Marcin Smołka, a Planowania Sieci specialist, discussed energy distribution issues. A walking tour to the Old City Hall allowed participants to explore the current draft of the development strategy for the city.

Planning Priorities and Sustainable Planning Objectives

Based on the morning presentations, key planning priorities were proposed, and consequently discussed and agreed by participants. These include: transport and mobility (particularly due to congestion as a result of the limited capacity of the current road network, but also due to the construction of a number of new roads and motorways and the associated increase on private car use, CO_2 emissions and noise issues), air quality (despite the general improvement in the area, mine-related emissions such as NOx, Sox, Benzene and dust – PM_{10}, in particular, are still an issue), energy (due to the significant heat loss in old buildings, the increasing rates of energy consumption and the associated CO_2 emissions), expanding urban areas (issues associated with uncontrolled development), and water management (due to poor quality of surface waters, in the river running through Gliwice in particular, and to flooding areas).

The afternoon session included a focused group discussion among participants, to determine the sustainability objectives and indicators associated with each of the planning priorities above. The objectives can be summarized as follows:

- ***Improve mobility:*** improve road infrastructure; minimize through-traffic in the city centre; reduce private-car dependency; improve public transport (i.e. railway); and provide alternative means (e.g. cycle-ways).
- ***Improve air quality:*** minimize emissions to comply with air quality standards, particularly for dust ($PM_{10}$and $PM_{2.5}$) and CO_2.
- ***Optimise energy efficiency:*** and reduce consumption; improve insulation in old buildings (to minimize energy loss); improve insulation in the central heating infrastructure (i.e. pre-insulated pipes; and extend urban central heating and gas piping systems (to cater for detached houses and blocks of flats).
- ***Promote controlled expansion of urban areas:*** through local land use plans; provide better access to the city centre; improvement of local services; diversify the city centre functions; and enhancement of the public open space.
- ***Improve water management***: through water permission requests for sustainable water use; maintain and improve the water quality; identify investments/projects that have the potential to negatively impact on water resources; and control development on floodplains/flooding areas.

These objectives will be used to determine sustainability criteria (mainly based on European Directives and requirements) and indicators.

Preliminary Indicators

Indicators were proposed by participants, linked to the objectives for the city, which were as follows:

Sustainability Objectives	Indicators
Improve Mobility	• Car ownership. • Public transport use (%). • Number of new roads built. • Number of cycle-ways provided.
Improve Air Quality	• Concentration of pollutants (PM_{10}, CO_2, NOx, SOx, CO, etc.). • Contribution of 'low emissions' to the total emissions. • Energy consumption for low emission stoves (% change)
Optimise Energy Efficiency	• Energy loses (GJ/MW/kWh tonnes/m^3/y/). • Number (%) or modernized/insulated old buildings. • Number or surface area of buildings in relation to total urban area. • Length of newly built heating systems/year. • Number of newly adjoined beneficent/year.
Promote Controlled Expansion of Urban Areas	• Number of newly elaborated land use plans. • % of surface covered by land use plans. • Daily travel time to/back from the city centre. • Number of services in the city centre. • Increases on taxation.
Improve Water Management	• Water use by sector. • % of population connected to waste water treatment.

Potential Case Study

The Kopernika housing district and the Academic district were initially proposed as potential case studies. The Academic district was considered to be the most suitable real life project to be assessed by BRIDGE, as a number of studies have already been undertaken and, consequently, relevant information for the area is available.

APPENDIX C – Results of Second Round of CoP Meetings

Firenze, Italy – 3rd December 2009

Introduction and Context

The second CoP meeting gathered 14 participants, 6 of which were local planners and stakeholders (i.e. non BRIDGE participants). The aims of the meeting were to:

- Define the alternatives to be assessed in the Firenze case study;
- Verify the relevance of sustainability objectives and indicators defined during the kick-off meeting; and
- Select objectives and criteria in relation to social and economic aspects.

Case Study

After wide discussion and reconsideration of the potential case studies suggested at the kick-off meeting, it was agreed to assess two alternatives for the future maintenance and development of Cascine Park. Considering the park's historic importance, operations on the Cascine must take into consideration its cultural heritage character and the legal bindings connected to them, leaving scarce room for modifying the present asset of plants. Therefore, the following alternatives were proposed:

(a) Refurbishment and restoration of the park.
(b) Refurbishment and restoration of the park and planting of new trees along the city streets and on public places (and consequent effect on urban canopy layer and removal of areas for traffic and parking).

With regards to the alternatives, it was observed that "doing nothing" is not realistic as the park urgently needs intervention. Nevertheless, this alternative might be taken into consideration as a reference scenario in order to confront impacts from this option with those from the examined operations.

The park is multifunctional and supports a number of functions and activities, including: custody of a range of species; aesthetic and historical features; sport and leisure time activities (racecourse, tennis court, extended lawns, flea markets, luna park with respective parking areas); public functions (military school, public deposits; and activities which wish to escape from public control (prostitution, drug market). The project of the new tram in Florence affects the park as there will be a stop at the eastern end of the park. The different alternatives have different implications for these functions, or act in selective manner onto some of them, and have different implications for management and maintenance costs of the areas. The case study will be mainly assessed with regard to its potential impacts on air quality and thermal comfort generated by an increase of the number of trees.

Revised Objectives and Indicators

The sustainability objectives and indicators proposed during the first CoP meeting were revised, selecting those which were relevant and reflected the specific issues posed by the alternatives for Cascine Park. New indicators, particularly socio-economic ones, were also proposed.

ENVIRONMENTAL	
Sustainability Objectives	**Indicators**
Improve Energy Efficiency	• Urban temperature outdoors (compared to rural temperatures). • Potential renewable energy from the volume of biomass produced.
Increase and Improve Green Space Areas	• Number of trees/per person/hectare (and number of trees planted). • Density of green areas (m^2/inhabitant). • Accessibility (distance by foot/bike, and number of public transport links). • Number of services per person in the green area. • Biodiversity (plant species, pollen season, etc.)
Improve Air Quality	• Concentration of pollutants (PM_{10}, $PM_{2.5}$, NOx, CO).

SOCIO-ECONOMIC	
Mobility/parking space	
Criteria	**Measurement Units/Source**
No. of parking lots added/cancelled	No. (defined by project)
Connection to public transport	GIS
Public approval, aesthetics	
% of persons approving	% of people that approves of the project
Multifunctionality	No of different functions (project)
Accessibility of public green areas	% of the population (residents) living in a 300m distance
Security	
No. of criminal acts registered	Only measurable ex-post
Costs and benefits	
Realization costs (public)	€ (project)
Realization costs (private)	€ (project)
Maintenance costs (public)	€/year (project)
Maintenance costs (private)	€/year (project)
No. of new economic activities	Annual turnover (project)

Helsinki, Finland – 20th January 2010

Introduction and Context

The second CoP meeting in Helsinki gathered 16 participants, 7 of which were local planners and stakeholders (i.e. non BRIDGE participants). The participants elaborated upon the environmental and socio economic indicators relevant to the urban planning practice in the city and, in particular, to the Meri-Rastila case study.

Case Study

The area identified for development is that within 600m from the Metro station. The neighbourhood is a suburb, characterized by buildings built in the 1960s and 1980s (the population has increased from 16,000 inhabitants in the 60s to 30,000 today). The quality of the buildings is poor, most of them are social or rental dwellings. There is no real urban context in the area, there are lots of trees and no real urban services. The density e-factor is 0.6 (i.e. 60% of the land is built and 40% maintained as green area). This is a reasonable density, but is a bit lower than that of new developments that show an e-factor of 0.8. The area is predominantly inhabited by immigrants. About 30% of the inhabitants are not able to speak the Finnish or Swedish language. In the area there are no social problems yet, but there are fears that problems might occur in future. The planning department wants to anticipate any potential problems and counteract by raising the quality of living in the area.

The area has an important recreation function for the inhabitants of the city of Helsinki and its surroundings. Locals want to maintain the open spaces, greenery and amenity of the area – there is lot of opposition to planning in green areas. In addition, there is a regional recreation route along the coast in Meri-Rastila. The plan must maintain the nice forest areas, as well as the geological formation (an ice-age rock outcrop in the middle of the plot) on the hill-top covering an area of 30mx60m which gives character to this forest part of Meri-Rastila.

The planning objectives for the area are:

- At city level: to provide new housing for the growing metropolitan areas (100.000 people is expected), built to address climate change (i.e. densification of urban structure, focus on railway and metro stations), and places of work mixed with housing.
- At neighbourhood level/Meri-Rastila level: to deal with demographic polarization (i.e. immigration issue), to move towards more owned dwellings and bigger apartments, to improve services and to provide a more positive image to the area (to attract new residents).
- With regard to green space/nature: to maintain sufficient and continuous recreation and habitats, and to improve accessibility to nature areas.

Three preliminary alternatives have been proposed for discussion purposes only during public consultation. These alternatives are not final; a new alternative will develop after the public consultation process.

- Alternative 1: 5-storey apartments, 500 residents, minimal impact on green spaces and nature, little effect on the character of the area. This is a minimal impact alternative. It is expected that this alternative will have little impact on the planning objectives.
- Alternative 2: Two dense groups of apartments. 5-storey apartments and row of houses accommodating 1,500 residents. Hilltop built; slope unbuilt. No connection to the sea and no real improvement of Meri-Rastila's character. Green environment but stand-alone buildings in the forest and no connection to exiting dwellings nearby. The area will not be self sufficient in terms of services. This alternative seems to lack character and it will not bring about much improvement to the area.
- Alternative 3: Residential building around the hilltop all the way down to the waterfront. Office space, maximum 1,000 work-spaces and 1,800 residents. More urban with sea views, various residential building types. Some public services planned for this alternative: primary school, day care centre. The sea views allow increasing profitability of buildings.

The alternatives could be assessed in terms of cost (realization and profit), social cohesion, air quality (i.e. there is a motorway running beside the plan area, in addition to the potential removal of forest and green areas), and energy consumption.

Revised Objectives and Indicators

The environmental indicators defined at the kick-off CoP were used as starting point to further define environmental and socio-economic indicators that are relevant for the assessment of the planning alternatives in the Meri-Rastila area.

ENVIRONMENTAL	
Sustainability Objectives	**Indicators**
Optimise Energy Consumption	• Energy demand (i.e. electricity consumption per dwelling); • Energy balance in buildings (i.e. energy heating); and • Percentage of energy from renewable sources.
Protect the Water Balance	• Water balance: surface run-off, evapotranspiration, and filtration.
Improve Air Quality	• Concentration of pollutants (ozone and particulate matter); • Greenhouse gases and CO_2 emissions per capita; and • Emissions from transport and split per type (private and public).
Enhance Human Well-being	• Density of developments (persons/m^2); and • Population exposure to air pollutants.
Anticipating climate change	• Carbon intake (i.e. removal of carbon sinks); • Material reuse (e.g. soils); and • Number of zero-carbon buildings.

SOCIO-ECONOMIC	
Sustainability Objectives	**Indicators**
Housing Demand	• Number and type of dwellings; • Population growth; • Demand for housing types; and • Percentage of owned/rented dwellings.
Social Inclusion	• Access to housing; • Social class/ethnical group; • Age group of residents; and • Number of family households.
Accessibility (Transport and connectivity)	• Travel time to work; and • Use of public transport.
Services and Infrastructure	*
Amenity and Recreation (physical and psychological health)	*
Cost/Benefits of Planning Intervention (Building costs and job creation)	*

** There was not time to discuss potential indicators associated to these objectives.*

Gliwice, Poland – 28th January 2010

Introduction and Context

The second CoP meeting gathered 25 participants, 12 of which were local planners and stakeholders (i.e. non BRIDGE participants). The participants reviewed the environmental and socio economic indicators proposed at the kick-off meeting, adapting them to the specific considerations of the case study. The groups were asked to:

- Review the previously defined indicators to ascertain that they are relevant to the study area (i.e. Academic district) and to ensure that they address the key issues in the development of the area.
- Define additional environmental and socio-economic indicators that are needed to evaluate the sustainability of the proposed alternatives.
- Prioritize the indicators according to their level of importance/significance.

Case Study

There is a necessity to create a fully equipped campus at the Academic District. For the planning authority, this are represents a landmark for the proper development of the town. The challenge is the limited geographical extent of the district and the need to optimise space and solutions, as well as the environmental loads to the carrying capacity of the area.

A number of alternatives have been considered for the area:

- Scenario 1 – ‘Minimum’. In this scenario the existing state of the buildings (academic and dwellings), built up spaces and the disposal of internal traffic will remain the same. The change will derive from the construction of the trunk road (already ongoing) which will influence communication and accessibility to the district.
- Scenario 2 – ‘Sports Hall’. This scenario assumes that the development plan zoning does not occur (i.e. the area remains the same) except for the construction of the sports hall, which will entail an additional load of people in the area.
- Scenario 3 – ‘Centre of New Technologies’. This scenario entails the construction of a new centre, consisting of a 7-storey building with rooms for didactic and scientific purposes. The design of the buildings entails and intelligent approach incorporating sustainable energy use (e.g. heat energy from solar collectors, energy recovery, etc.). It includes the creation of public spaces and relays on the development and upgrading of local roads.
- Scenario 4 – ‘Maximum’. This scenario would comprise the development of all the aspects considered in scenarios 1 to 3.

From the planning point of view, the focus is on the provision of new services in the area. The erection of the different buildings is likely to lead to very little environmental change but all the aspects of the development might do (e.g. the stadium to be built will attract people from outside Gliwice – this will attract revenue but increase the environmental load and the associated potential effects at inter-regional level, due to increased use of the area, the motorway and transport-related activities).

Revised Objectives and Indicators

The environmental and socio-economic indicators defined at the kick-off CoP were reviewed and adapted to the assessment of the planning alternatives in the Academic District.

ENVIRONMENTAL		
Sust. Objectives	**Indicators**	**Priority**
Improve Air Quality	• Spatial distribution of pollutants (PM_{10}, $PM_{2.5}$, NOx, SOx, CO, CO_2) • Contribution of 'low emissions' (from single boilers located in the low residential dwellings) to the total emissions • Total emissions (% change) • Relationship between pollutant concentrations and wind direction	1
Improve Energy Efficiency	• Energy demand (kW/h/m^2 or % change) • Heating demand (kW/h/m^2 or % change) • % and structure of thermo-insulation	1
Improve Water Management	Water quality and quantity* • Urban water use • Urban water supply • % of waste water treated • River capacity (both quality – BOD, and quantity - volume) • WFD quality values	1
	Flooding • % of "solid" area (and % of change) • Flooding zones Infrastructure • Sewage capacity (volume) • % of houses connected to the WWT • Volume of discharge	1

** It is worth noting that at the end of the discussion it was stated that the key limitations to further development in the area are the water quality and quantity loads into the main river.*

SOCIO-ECONOMIC		
Sust. Objectives	**Indicators**	**Priority**
Improve Mobility	• Number of pedestrian streets (Km) • Public transport use (%) • Length of new roads built (Km) • Length of cycle-ways provided (Km) • Number of parking places built up	1
Controlled Expansion of Urban Areas	• Number of administrative decisions	2
	• Accessibility of district from Silesia metropolitan area (hours to/from)	1
	• Number of specific services in the district	4
	• % of new public space	4
	• Increase on incomes	3

Athens, Greece – 18th February 2010

Introduction and Context

The second CoP meeting gathered 29 participants, 11 of which were local planners and stakeholders (i.e. non BRIDGE participants). The participants were divided in two groups to separately address environmental and socio economic objectives and indicators. The groups were asked to:

- Review the previously defined indicators to ascertain that they are relevant to the study area (i.e. Thivon Avenue district) and to ensure that they address the key issues in the development of the area.
- Define additional environmental and socio-economic indicators that are needed to evaluate the sustainability of the proposed alternatives.
- Identify those indicators that are crucial for the assessment.

Case Study

Thivon Avenue runs through 6 Municipalities of Athens, one of these being Egaleo where major improvements are proposed. The key problems in the avenue include: heavy traffic load; air pollution ; environmental problems due to the neighboring industrial area of Eleonas; lack of open and green spaces; lack of parking spaces; degraded urban infrastructure (e.g. destroyed pavements making very difficult the mobility of pedestrians, especially for disabled people); poor quality of buildings; “visual pollution” (e.g. large publicity panels, etc.); and high temperatures experienced in the city as a whole (thermal discomfort).

The goal of this project is to create an oasis in this problematic area and present a pilot project that other municipalities will also follow. The objectives of the regeneration are to a) create thermal comfort conditions, b) improve the microclimate, c) increase green spaces and improve ventilation/ air circulation conditions, d) appropriate choice of materials e) respect the traditional architectural style of the area. Some of the proposed interventions include:

- Use of photocatalytic cool asphalt (with self cleaning, anti pollution properties, antimicrobial properties)
- Use of ceramic tiles on pavements (cool materials that do not absorb sunlight, natural materials, easy to clean).
- PV, and PV lighting devices.
- Installation of Earth to air heat exchangers for cooling and ventilation.
- A bioclimatic solar tower that collects air pollution from near the road and transfers it at a height over the canopy. It also collects solar energy that can be used and is aesthetically pleasing.
- Use of pergolas for shading.
- Increasing green spaces by tree (already mature, appropriate, non allergenic) and bush planting for microclimate improvement and shading.
- Rehabilitation of the main squares around the avenue.

Three alternatives are proposed for assessment:

a) Use of photocatalytic technology and cool materials and asphalt, green spaces, earth to air heat exchangers, solar control chimneys.
b) Same as alternative ‘a’ but without the photocatalytic technology.
c) Same as alternative ‘a’ but without the earth to air heat exchangers or solar chimneys.

The assessment of alternatives will focus on the economic implications of the different technologies and materials, the effects on air quality and thermal comfort and the effects on traffic circulation and associated impacts.

This case study will be used to validate the DSS outcomes (by contrasting the results provided by the University of Athens with those obtained by BRIDGE researchers and, consequently, evaluating the consistency and coherency of the DSS outcomes).

Revised Objectives and Indicators

The groups revised the objectives and indicators defined during the first CoP meeting, contextualizing them to the case study considerations. The objectives and indicators were subsequently categorized in order of significance. The table below lists the objectives in the order of priority set by the participants. The crucial indicators are noted with an asterisk.

ENVIRONMENTAL	
Sust. Objective (in order of priority)	**Indicators**
1. Reduce Thermal Discomfort	• Average outdoor temperature (air) and humidity*; • Average surface temperature (roads, buildings, etc.)*; and • Wind speed.
2. Improve Air Quality and Reduce Emissions	• Concentration of pollutants (NOx, SOx, PM_{10}, $PM_{2.5}$)*; • CO_2 emissions; • Source of emissions (% per building/sector type); • Number of days above established air quality thresholds; and • Effects of meteorological conditions (e.g. temperature) on concentrations.
3. Increase Green Space Areas	• Area (% or m^2) of urban green space*; • Number of trees planted; and • Types of trees planted.
4. Optimize Water Use	• Volume of water used (for irrigation).
5. Improve Energy Efficiency	• Energy consumption for lighting the avenue; and • % of energy from renewable sources* (i.e. solar panels).
6. Optimize Quality of Materials Used	• Solar reflectance of materials used.

SOCIO-ECONOMIC	
Sust. Objective (in order of priority)	**Indicators**
7. Mobility	• Road traffic intensity, • Quality of pedestrian sideways, • Number of parking slots.
8. Public health and safety	• Number and severity of road accidents and pedestrian injuries, • Number of people suffering from short-term effect of air pollution (upper respiratory infections such as bronchitis and pneumonia, allergic reactions) • Number of people suffering from long-term effects of air pollution (e.g. chronic respiratory disease, lung cancer, heart disease)
9. Social inclusion	• Extent to which roads and sideways can be used by disabled or differently able people and groups (e.g. number of safe-street-crossing points, number of repose places along the street), • Local community composition – compared to other areas: % of elderly

	people, foreigners, low-income families etc.
10. Economic criteria	• Financial costs of the interventions, • Estimated side-effects on local economy
11. Place identity	• Aesthetic value of the area and changes due to planning intervention

It is worth noting that the participants perceived 'cost' being the key consideration when assessing and selecting planning alternatives. Therefore, the cost implications will play a significant role (i.e. will have a greater weight than environmental or social criteria) in the assessment of the Thivon Avenue case study.

London, United Kingdom – 1st April 2010

Introduction and Context
The second CoP meeting gathered 10 participants, 4 of which were planners and stakeholders from the Greater London Authority – GLA (i.e. non BRIDGE participants). The aim of the meeting was to identify a case study area for the application of the DSS, and to revise the planning objectives and indicators discussed during the first CoP meeting.

Case Study
GLA participants proposed the Central Activity Zone (CAZ) as a case study for the application of the DSS. The CAZ covers the London central area, including the CBA and the commercial centre, with an overall area of approx. 3,300 ha – covering partly or entirely 10 boroughs with 280,000 inhabitants. The CAZ includes three major parks (Hyde Park, Regent's Park and Green Park) and some minor urban green areas. It is targeted and delimited by the London planning strategies and it is object of specific objectives and goals which are also related to urban metabolism issues. The primary planning goals for the area are to (a) increase green-space, (b) improve air quality, (c) reduce the UHI effect (heat-island), and (d) prevent flash-floods. The policy objective related to Climate Change was described as a crosscutting argument triggering mitigation and adaptation needs.

The area being consolidated as a planning unit (although not corresponding exactly to the delimitation of boroughs) should facilitate data retrieval. Policy scenarios including quantitative goals can be derived from the objectives of the London plan.

Revised Objectives and Indicators
The planning objectives discussed during the first CoP meeting with reference to the Greater London area, were revisited and defined with regards to the specificities of the case study area. Time constraints impeded in-depth analysis of potential issues, particularly in relation to socio-economic aspects, and hindered the prioritisation of indicators. However, a participant suggested that indicators are prioritised according to the number of issues they address.

ENVIRONMENTAL	
Sustainability Objectives	**Indicators**
Mitigate Heat Island Effect	• Ambient temperature (at 1m above street level); • Number of days above 33°C /per area; and • Health impacts and number of deaths/day.
Increase Urban Greening	• Canopy surface newly created; • Access to green areas; • Costs of maintenance; and

	• Benefits in terms of reduced flood risk.
Mitigate Flash Flooding	• Number/extension of "hot spots"; • Number of residents affected; • Values/infrastructure at risk; and • Cost of drainage.
Decentralize Energy Production	• % of energy created; and • Additional heat generated.
Reduce Air Quality Problems	• NO_2 Concentration; • SO_2 Concentration; • PM Concentration (PM_{10}, $PM_{2.5}$); and • Health impacts.

As there was little time during the meeting to discuss social and economic aspects (although a small number of socio-economic issues associated with environmental considerations were identified and are listed in the table above), the following objectives and indicators were suggested to the participants and are currently under review. They are based on the renewed Major's plan for London, and address issues which are potentially relevant to the CAZ and, in particular, to the greening policy for this area.

Planning Goal	**Indicators**		
	Environmental	**Social**	**Economic**
Reduce social exclusion/ Reduce health inequalities	Improvement of air quality in residential areas	No/extension of less favoured residential areas interested	
Increase/improve housing		Number of affordable dwellings improved/built	
Create mixed use developments	Number of mixed use developments		Office /commercial space planned/created in mixed developments
Provide office space for development	Office /commercial space with realized with low emission standards		Office/commercial space planned/created