SEVENTH FRAMEWORK PROGRAMME

THEME 6: Environment (including climate change)

Contract for: **Collaborative Project**

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Table of Contents

1. Introduction

1.1 Purpose of the document

Last 8th of December a Foresight Exercise was held in London, with the participation of local and international experts, in the field of urban sustainability, as well as BRIDGE team members. This document is the **Report of the Foresight Exercise.**

The **aim of this document** is to describe the methodology applied in the Foresight Exercise, including its preparation. The report discusses the results obtained as well as the link with the next steps of DSS *Implementation* (WP7).

1.2 Document Structure

Chapter 1 is the introduction of the document (current chapter) which includes: the purpose of the document, the document's organization, the list of applicable and referenced documents and the BRIDGE project overview.

Chapter 2 presents the main objectives of this exercise.

Chapter 3 describes briefly the theoretical concepts of foresight and how they are translated in the exercise organized in BRIDGE. It also explains the evaluation concept behind the DSS and the simplifications made in order to make possible its simulation during the foresight exercise.

Chapter 4 focuses on the preparation phase: main steps done in order to identify the lack of information on the planning alternatives and how to deal with it. The participants' selection process is also described.

Chapter 5 is dedicated to the foresight exercise itself, and comprehends: i) the scenarios presentation; ii) the main ideas resulting from the thematic debate, where the participants were asked how to make a sustainable city, considering the limitations and opportunities of each scenario; iii) the results from the case study debate, where preferences related to planning alternatives were discussed and the Delphi questionnaire was performed (twice).

Chapter 6 presents the conclusions of this exercise: the problems encountered, as well as the potential of the data collected in the next steps of WP7.

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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 pollutant fluxes. However, there is poor communication of new knowledge to end-users, such as planners, architects and engineers.

BRIDGE aims to illustrate 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 to 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 determine the sustainability 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 the 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 a 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 pollutant fluxes.

2. Objectives of the Foresight Exercise

The DSS assesses the advantages and disadvantages of planning alternatives developed for each case study. It combines environmental data generated by models with socio-economic data provided by statistical sources and by policy makers.

In short, DSS calculates a multi-criteria function which combines the values of a given set of indicators with their respective weights. Indicators values are either given by BRIDGE physical models or by statistical sources or local experts' knowledge (socio-economic data); weights reflect the subjective importance ascribed to the different indicators by the intended end-users of the DSS (planners and decisions makers).

A

A *simulation of DSS application to BRIDGE case studies* was the first objective of the foresight exercise. The DSS evaluation process requires scores of the relevant indicators (calculated with objective data, given by BRIDGE models or other sources) and weights (subjective appreciation by end-users of the relative importance of relevant parameters).

Even when the DSS is complete, weights will not be stored in it, because they depend only on end-users choices. However, in the development phase it is essential to know how the evaluation algorithm reacts to different weights. The foresight exercise is a means to collect different sets of weights, and to test the sensitivity of the multi-criteria formula.

For this, participants took the role of decision-makers, choosing weights. A simplified version of the DSS was developed, considering a limited number of indicators. The essential information was collected and estimated with the help of local experts. These allowed simulating the DSS and obtaining results in four case-studies, considering the planning alternatives proposed by the municipalities.

This simulation helped BRIDGE team, and also CoP members, to get a more exact notion of the final outputs of the software being developed.

B

Another main objective of the foresight exercise was to analyze *how decision-makers priorities, and respective indicators' weights, change in response to different future scenarios*, focusing on macro dimensions, such as climate change, energy supply and economic performance. Different possible futures were discussed using a scenario analysis methodology, and participants defined the extent to which weights vary accordingly to each scenario, using a Delphi questionnaire. It is essential to understand how different future perceptions influence evaluation results, in order to facilitate the use of DSS in other cities.

C

This exercise also aimed at promoting the *debate with experts and urban planning practitioners (especially from the private sector, as it was indicated by the Reviewers in mid-term review of the project) on what will be sustainable urban policies* in the near future and how to integrate them in the current urban policy.

D

The *interaction between the BRIDGE team and the local experts was also an objective, as it contributes to* a better understanding of local experts' expectations about DSS, and of the planning alternatives under evaluation.

3. Foresight exercise – Concept and Methodology

The applied methodology was developed specially for this exercise, and was based on University of Aveiro expertise in foresight techniques. This section contains a brief presentation of this type of methodologies and its usual field of application is made, followed by a short description of the methodology followed during the exercise is provided, showing how the foresight techniques were adjusted to the BRIDGE project needs. Last but not least, the evaluation methodology of the BRIDGE DSS is summarily explained, as well as the adjustments made for its application during the exercise.

3.1 Foresight techniques

Foresight analysis is widely mentioned in the social sciences as a technique that enables people to think ahead and consider, model, create and respond to future eventualities. It also draws attention to a specific problem's justification: "how should funding decisions today be affected by expectations of the future?" (Rappert, 1999). Thus, foresight techniques can be described as organized and systematic efforts to look ahead and to choose more effectively (Grupp and Linstone, 1999), whatever the area in which is applied to.

The use of foresight techniques emerged in private organizations around the 1960s and continues to be developed and applied to a widening range of fields, although it was developed in the technological field. Nowadays it is also applied to national and regional strategy definition (Ahola, 2003).

Foresight is defined as "a process by which one comes to a fuller understanding of the forces shaping the long-term future which should be taken into account in policy formulation, planning and decision-making. Foresight is, therefore, closely tied to planning." (Grupp and Linstone, 1999)

It is recognized that, in complex societies, knowledge relevant to longer-term policymaking is typically widely distributed, rather than centralised in government – or even a few academic or corporate – offices. Thus, new approaches are required to fuse decision-making with longer-term perspectives and wider networking, and foresight techniques constitute one of these approaches that enable the information gathering from a diverse set of stakeholders (Miles and Keenan, 2002).

Foresight techniques

There are several techniques, but the more frequently used are *analysis of scenarios* and *Delphi questionnaires*. "The first group is aimed at developing the capacity to adapt strategies to exogenous development paths of the environment, while Delphi surveys are designed to obtain expert guesstimates about the future evolution of selected variables." (Grupp and Linstone, 1999)

Scenario analysis

> The definition of scenario in this context comprehends both descriptions of possible future states, descriptions of developments, and it also covers predictive approaches with sensitivity testing (Börjeson et al., 2006).
>
> Scenario analysis, applied to planning, is intended for helping the decision making process in the present, considering future restrictions. Thus, the scenarios should not be faced as forecasts or strategies: they are based on different assumptions about the future, focused on certain risks and opportunities involved in development strategies to be designed (Marques et al., 2009).

Scenarios are developed as coherent stories about future possibilities, which help experts to preview the implications of uncertain events (that are uninfluenced by the political decisions), helping participants to organize their thinking about what would be desirable actions to cope with the situation presented in the scenarios. The ultimate goal is to increasing the robustness and flexibility of the development policy to be implemented.

The scenarios construction begins with the identification of the main external drivers and with the definition of the evolution trend for each one (positive or negative). The combinations of the different evolution trends for the chosen drivers are the bases for each scenario. Subsequently, each scenario should be enriched with vivid and creative details, generating a history: the more absorbing, clear, compelling and entertaining the presented scenario is, the bigger the changes of its message being understood (Fahey and Randall, 1998). The last phase of the exercise is the discussion of the implications of each scenario, and the analysis of strategies / actions that can be implemented to allow future developments to meet the described scenarios.

Delphi survey

The Delphi questionnaire is used for the collection and synthesis of experts' opinion, concerning emerging developments, for which there is little or no empirical data or on future developments in which the simple extrapolation of trends is considered inadequate (Gordon and Pease, 2006). This type of surveys consists on objective and clear questions on a certain thematic, with the aim of collecting information about their views on the evolution, but also to get theirs reaction to the opinion of the other experts (Marques et al., 2009).

Typically this study involves several rounds of questions, the dissemination of the results, as well as of the reasons that support the most of conflicting opinions (this is done after every round). This procedure is repeated several times until reaching consensus among the participants, which is often not possible due to logistical limitations or time (Powell, 2003).

Although these two techniques are traditionally used separately, there are some studies on their joint application (Saritas and Oner, 2004, Marques et al., 2006, Marques et al., 2009). The qualitative nature of the scenario analysis and the quantitative nature of Delphi surveys can be balanced if they are applied together, but the specific methodology depends mainly on the exercises' goals.

3.2 Exercise methodology

The main goal of the exercise was to understand how experts' priorities changed with the scenarios and how these changes affected the DSS simulated results.

To achieve this goal, a following foresight exercise methodology was designed:

1. Main urban sustainability drivers were identified (climate change, energy and technological development and economy).
2. Three extreme scenarios were created based on different combinations of positive or negative evolution for each driver / dimension.

	Climate Change	Energy / Technological Development	Economy
1	+	+	+
2	-	+	+
3	+	-	-

3. Planning alternatives were studied and characterized, in order to understand which indicators were more relevant to the decision between the several planning alternatives in each case study – this was translated into a questionnaire, on the relative importance of each indicator, in every scenario.

At this stage, all the material necessary for the foresight exercise was finished.

4. The scenarios were presented and discussed with the participants, organized according to three themes on urban sustainability components: physical (urban design), economic (urban attractiveness) and environmental (energy).
5. After a more general debate on urban sustainability (which is the ultimate goal), a case study debate was held, concerning the priorities in political decision in each city, accordingly to each scenarios. The questionnaires was explained and handed out after a brief discussion on the main priorities, followed by an arguments exchanged on the more case specific issues.
6. After the results presentation, participants had the opportunity to change their answers.

The scenarios were the exercise’s framework and introduced the variability that was needed to test the DSS sensitivity to changes (through a simulation). The Delphi survey was used to translate the experts’ opinion, concerning the relative importance of each indicator, into numbers in all scenarios.

3.3 Evaluation process in DSS

The DSS, along with the models that simulate the impacts of the planning alternatives on physical parameters, such as air quality, water and energy parameters, has an algorithm that aggregates the physical indicators, at both geographic (intervention area and surroundings) and temporal (annual) levels.

The calculated indicators are then used in an evaluation algorithm. This process will be defined briefly (González et al., 2010):

Step 1 Defining the criteria and indicators for assessing planning alternatives

The end-user is provided with a list of criteria (dimensions of analysis), such as:

- Pollutants and Carbon (PC),
- Energy
- Water Balance (WB),
- Thermal Comfort (TC),
- Green spaces
- Materials
- Land use (LU)
- Economic Viability (EV)
- Mobility/ Accessibility
- Social Inclusion
- Human Well-being

and corresponding indicators, such as:

- CO concentration (PC),
- Infiltration (WB),
- Anthropogenic heat loss (TC),
- New urbanized areas (LU);
- Effects on local economy- employment (EV).

The end-user is then asked to define which of the suggested criteria and indicators are relevant for the evaluation to be performed in the DSS, of the planning alternatives defined by them. All indicators must be related to the value of the planning action, directly or indirectly. There is the choice to include new indicators, where the end-user has the corresponding data, as these additional indicators will not be calculated by BRIDGE models.

Step 2 Calculating and Setting Indicator Values for each Alternative

In this step, indicator values are provided for each alternative considered, for every indicator chosen. The indicators values can be given either by BRIDGE models or by the end-users when the first possibility is not an option.

Nevertheless, one has to consider that it is difficult to calculate absolute values of some indicators (mainly the socio-economic ones, that can’t be calculated by models, like the all the others, that result from the models incorporated in DSS), given the lack of reliable data.

Steps 3 and 4: Weighting Indicators According to their Priority and Normalising Weights

The end user is asked to rate each criterion according to its priority in the city – this is mainly a political decision. A scale of relative importance is calculated based on a pair-wise comparison (applying Analytic Hierarchy Process - AHP), where the user defines the relative importance between pairs of criteria.

The same procedure is made for each indicator, grouped accordingly to the criterion (e.g. if four indicators were chosen for a certain criterion, they have to be rated against all the others three). A scale of relative importance is calculated concerning the groups of indicators of each criterion.

The results from these steps are the weights of the criteria and for indicators of each criterion.

Step 5: Scoring Indicator Values according to Performance in each Alternative

The main goal of the DSS is to compare planning alternatives, and one of its main problems is the absence of reliable information concerning the social and economic dimensions to do so. One way to overcome this problem is to use relative values, comparing each planning alternative to a *reference situation*.

This could be the actual situation (business as usual scenario - BAU) or one of the alternatives, when the comparison with the BAU does not make sense. For example, concerning employment, one cannot say that employment in the intervention area is going to double if, at current time, there is no employment there. However, it is possible to say that the alternative 1 will provide two times more employment than the alternative 2.

Thus, the indicators’ score (S_i) are calculated considering the changes introduced by the planning alternative being analysed ($I_{i,PA}$), compared to the reference situation adopted ($I_{i,R}$). For example, to calculate the indicator concerning the cost of the intervention in Gliwice, and considering the construction of sports centre to be the reference situation (R), and the construction of an energy technological centre to be the planning alternative under evaluation (TC), it is necessary to know the cost of both alternatives.

$$S_{\cos t,TC} = \frac{I_{\cos t,TC}}{I_{\cos t,R}} = \frac{18{,}75M€}{47{,}50M€} = 0{,}34$$

This means that the planning alternative cost represents 34% of the reference situation.

Step 6: Scoring Criteria Combining Relative Weights and Values of Indicators and Aggregating Criteria to Obtain Relative Values for Each Alternative

The score of each criterion is calculated by a Cobb-Douglas function of indicators' scores and weights (Romer, 2005). One of the advantages of this type of functions is that it enables to deal either with relative or absolute values of indicators, and it is sensitive to the changes in scores (indicator performance) as well as in weights (indicator importance/significance).

For example, consider a criterion with 3 indicators. The evaluation formula for planning alternative *i*, would be calculated in the following manner:

$$S_{C,i} = S_{C1,i}^{\alpha 1} \cdot S_{C2,i}^{\alpha 2} \cdot S_{C3,i}^{\alpha 3}$$

In this function $\sum \alpha = 1$, which determines the normalization procedure for the weights attributed by end-users.

The overall score of each alternative is calculated in the same way as the criteria scores, using a function of criteria scores and weights, to facilitate comparison between the alternatives.

$$V_i = f\left(S_{ij}, w_j\right)$$

being

- V_i value of the planning alternative *i*
- S_{ij} score of the criterion j in planning alterative *i*
- w_j weight of criteria *j*

For example, considering four criteria, the formula would be: $V_i = S_{1,i}^{\omega 1} \cdot S_{2,i}^{\omega 2} \cdot S_{3,i}^{\omega 3} \cdot S_{3,i}^{\omega 4}$

In summary, one can say that this evaluation process is based on a value function using scores and weights: the first translate the relative performance of the planning alternative under evaluation when compared to a reference situation; and the second the relative importance ascribed by the end-users to the indicator compared to the others indicators used.

Naturally, BRIDGE DSS results are more than just a number: this represents only a summary of all information collected. Indicators values can be observed, in what concerns their geographical and temporal variability.

"Based on the (...) results, the end-user or decision-maker can make an informed decision on the suitability of alternatives by looking at how the different alternatives affect the socio-economic and environmental components of the urban context" (González et al., 2010).

3.3.1 Evaluation process in the foresight exercise

In the foresight exercise, some simplifications had to be made, in order to make a DSS simulation possible for the four case studies and for the three scenarios possible, in only one day. These changes were introduced at three levels:

-Criteria

In DSS definitions, there are four environmental criteria and only one socio-economic criterion, where all indicators directly associated with urban planning and economic viability are agglomerated. Attending to the formula used to calculate the final value (see section 3.3), this risks leading to a

biased analysis, since environmental parameters will have a bigger influence on the final value, unless end-users are sufficiently aware of the problem to discount for the number of variables.

To correct this, criteria were substituted by four dimensions, aggregating and disaggregating criteria, according to a logic which reflects the main concerns in urban planning: Land use / urban design, Economic viability, Energy and thermal comfort and Physical environment (see section 4.1.1 for more detailed information).

-Indicators

The list of indicators was reduced in order to isolate those which were expected to vary more with planning alternatives, in each case study (see Annex A.1).

BRIDGE and local experts were consulted in order to define the final list of indicators, and also to make reasonable estimations of their scores, in the cases where real data is not available (namely, models' outputs are not available yet). In the final versions of DSS, these numbers will be substituted by model's results.

-Rating process

The pair-wise comparison, for establishing the priority between dimensions and indicators, was not applied. To apply this process, to three alternative scenarios, in the context of the Foresight Exercise, would be too much time consuming, thus considerably reducing the time dedicated to the analysis of the planning alternatives and the corresponding political options, conditioned to the proposed future scenarios.

The rating process was based on a Delphi questionnaire where participants, divided by case study, were asked to indicate the relative importance of dimension and indicators. The answers were standardized, in order to obtain a result that is similar to the one of the pair-wise comparison process.

4. Foresight exercise – Preparation

This section is dedicated to the description of the work done before the exercise, which was divided into three components: the planning alternatives, the logistics and the scenarios' development. The work done with the local experts (from the BRIDGE team as well as external ones), led to a better understanding of the planning alternatives and their objectives, which are summarily described. Concerning logistics, only the participants' selection process is presented. The last component is referred to in the next section, along with its presentation and debate.

4.1 Preparation phase – Planning alternatives

This exercise required a long preparation phase, in order to characterize the planning alternatives of each case study and prepare the DSS simulation.

The methodology implemented was the following:

- redefinition of the planning alternatives, in order to make them more operational in what concerns the DSS

  The case studies are very different and naturally required different efforts in order to prepare the framework for this exercise. In what concerns Athens, Gliwice and Helsinki the definition of planning alternatives was on a more advanced stage, and the objective was to complement the physical characterization of the planning alternatives, with the political objectives that motivated them.

  There were some problems related to the London and Firenze case studies, where the planning alternatives were defined in a less concrete form. In what concerns London, with the collaboration of KCL, it was possible to define three planning alternatives to be applied only in this exercise.

  In the Firenze case study, the planning alternatives definition was behind schedule and, given the difficulty of organizing a debate on five case studies only in a day and the absence of available local experts, its exclusion was considered to be the best option. Nevertheless, the multiple contacts made with CNR and Firenze municipality elements led to the identification of the steps that should be taken in the near future.

- identification of the relevant parameters in the evaluation

  The final list of indicators defined in WP5 is very long, and it was neither possible nor desirable to consider all of them all in the foresight. The first step of the DSS application was the selection of the relevant indicators.

  In each case study, based on the objectives of the planning alternatives and on their expected impacts, some of the indicators were excluded. That is, when the indicators value was not supposed to change in the different planning alternatives, they were considered not relevant. BRIDGE local experts were asked to correct a preliminary list made by the organization team.

  This step is explained in detail in the next section.

- development of an estimate for the scores of the relevant indicators and dimensions

  For the DSS simulation to be possible it is necessary to have data on each of the selected parameters / indicators. In what concerns the physical parameters studied by the BRIDGE

models, the models' results are not fully available yet. For the socio-economic data considered to be important for the evaluation, some of the data was already made available, but the majority was not.

In order to address this, the University of Aveiro team proposed some scores for each indicator, and the local experts were asked to comment on this and changed them according to their better judgment. Case study coordinators were invited to comment on all of the scores and other local experts only on the scores that, when the DSS is ready, would be under their responsibility to fill in (the scores are in Annexes 3, 4 and 5).

The goal here was twofold: obtain numbers that allowed the DDS to be simulated and also to gather more information on the socio-economic aspects.

- development of calculation process that could simulate the evaluation process used in BRIDGE DSS

  The changes made into the DSS calculation process are explained in detail in section 3.3.1.

4.1.1 Selection of indicators

The final list of indicators in BRIDGE DSS was analyzed, concerning their relevance in each case study, and a selection by case study was made. The case study coordinators were asked to comment on and change a preliminary list made by the organization team, for each case study.

Having the indicators defined for the four case studies, it was necessary to think in the best way to apply the DSS evaluation formula. It was considered to be necessary to group the indicators in four main categories, in order to balance the weight of environmental and socioeconomic parameters in the final result. The chosen categories, reflecting main concerns in urban planning, were:

Land use / urban design	includes aspects related to attractiveness of urban space (aesthetics and services supply), equilibrium between green and built areas, and housing.
Economic viability	includes aspects related to the costs of the interventions, but also with the direct and indirect benefits that they will bring to the urban economy, in general and specifically in which concerns employment (qualified and total).
Energy and thermal comfort	energy is one of the main concerns nowadays, and this is also reflected on urban planning: renewable energy production, energetic efficiency and thermal comfort (to which is associated the need for energy consumption) are indicators associated to this criteria.
Physical environment	all indicators related to physical flows (air and water) and their impact on human well being are included in this topic; examples of indicators are air quality index, air quality impact on well being, GHG emissions, infiltration and potential flood risk.

Participants in each case study session were invited to give weights to these four main categories for each scenario. Afterwards, they were invited to weight the relevant indicators. In order to clarify the meaning of the indicators, a short description of each one is given bellow.

Table 1. Indicators used in the exercise, grouped by dimension

Physical environment	
GHG emissions	annual greenhouse emissions in the intervention area
Air quality index	synthetic index of the annual average air quality concerning NO_2, PM_{10}, $PM_{2,5}$ and O_3, and also the number of exceedences of NO_2, PM_{10} and O_3 (in relation to the EU Directive)
Number of inhabitants affected by air pollution	number of persons present in the areas with bad air quality (annual basis)
Evapotranspiration	water released in the non-built-up areas in the urban system (annual basis)
Infiltration	water absorbed in the non-built-up areas of the urban system (annual basis)
Potential flood risk	combination of the precipitation peaks and absorption capacity (annual basis)

Energy and thermal comfort	
Percentage of energy from renewable energy sources	annual average
Exterior thermal comfort	relation of wind speed and temperature (annual average)
Number of inhabitants affected by heat waves	annual average
Anthropogenic heat loss	energy (heat) lost by buildings (annual average)
N.º of persons with access to public transport	annual average

Land use / urban design	
Local green areas	per capita or absolute value, depending on what is more suitable for the case study
New inhabitants	
Reclamation of brownfields	recuperation of old industrial areas
Access to consumer services	
Leisure infrastructure (excluding green areas)	
Aesthetics	this indicator is very subjective, but one cannot omit it, since it is a important component in decision making

Economic viability	
Impact on the economy	net benefits for the urban area caused by the intervention
Cost of the intervention	cost of the intervention supported by the municipality
Employment created	
Qualified employment created	

The list of indicators used in each case study can be found in Annex 2.

4.2 Participants

The quality of the results of a foresight exercise is strongly dependent on the expertise of its participants. The invitations aimed at gathering local knowledge of the projects under evaluation by BRIDGE with knowledge on several aspects of urban sustainability.

The first step was to define, with the help of the case study leaders, which members of the local Community of Practice (CoP) should be invited. That is, who had the best knowledge of the projects under evaluation by BRIDGE DSS. At the same time, international experts on urban sustainability where identified, with the main goal of guaranteeing that their expertise was complementary to the expertise of the BRIDGE team members.

From the BRIDGE team, the invitation criterion was similar: members with local knowledge of the case studies and from some scientific areas of urban sustainability (economics and physical environment – e.g. air, water).

These efforts resulted in three types of invitations:

- to external experts on urban sustainability, concerning several dimensions of sustainable development;
- to local experts with knowledge of the projects under evaluation by the BRIDGE DSS (from BRIDGE team or not);
- to BRIDGE team members, with the aim of assuring that the expertise diversity of the BRIDGE team was somehow represented in the foresight exercise.

More information on this can be found on Annex 1, where the participants (and theirs fields of expertise) are listed.

Concerning Firenze, in spite of the efforts of the National Research Council (CNR) and University of Aveiro, it was impossible to have Italian experts (from the local municipalities or associated institution), which lead to the exclusion of that case study in the exercised.

The preparation and organization of the foresight exercise was a responsibility of the University of Aveiro. Nevertheless, for this to be possible the collaboration of Ainhoa González (TDC), Annemarie Groot (ALTERRA) and of Zina Mitraka (FORTH) was essential.

5. Foresight exercise – Process and Results

The foresight exercise was composed by three phases: scenario presentation; thematic debate and case study debate. In this section, these phases are shortly presented, preceded by the description of all moments of the foresight exercise.

It is important to understand the principles behind each scenario, since they are the basis of the thematic analysis and of the questionnaire results. The main measures that were proposed to enhance urban sustainability in the three scenarios are also described, although the complexity of summarizing a rich debate always leads to the exclusion of some interesting thoughts/ideas. For this we apologize in advance to all participants. At last, the quantitative results of the case study debate are presented.

5.1 Foresight exercise – main steps

The program of the exercise is presented in order to give a general idea of the integration of each methodological step.

BRIDGE presentation 9h30	Nektarios Chrysoulakis (FORTH) made a brief presentation of the BRIDGE project and of its evaluation mechanism.
Scenario presentation 09h45	An introduction to the exercise goals was made, followed by the three scenarios presentation.
Scenario analysis 11h15	Participants were divided into three groups, considering different urban policy themes: urban design, urban attractiveness, sustainability in energy consumption and production; participants were asked to discuss the policies necessary to build a sustainable city, in the context of each of the three scenarios.
Scenario analysis conclusion 12h30	Each group presented the main conclusions of their debate in a plenary session.
Short presentation of the case studies 14h00	Participants were divided into four groups, according to the case studies. A brief presentation of the corresponding planning alternatives was made by local experts or by the facilitators, focusing on their main characteristics and objectives, related to the trade-offs between socio-economic development and urban metabolism.
Debate on the relative importance of the dimensions 14h15	For each case study, relative priorities of the four dimensions were discussed according to each scenario: Urban planning and design, Economic viability, Energy and thermal comfort and Physical environment.
Questionnaire (1st round) 15h00	A questionnaire, specific to each case study, was made available to all participants, who were requested to fill it by prioritizing dimensions and indicators.
Debate on the relative importance of the indicators 15h15	Participants were asked to exchange opinions on the priorities established in each scenario, for the indicators associated with each dimension.

Results presentation 16h30	Eduardo Castro (UAVR) made a brief comment on the results of the 1st round of questionnaires, and pointed out some aspects that might have influenced them.
Questionnaire (2nd round) 17h45	Knowing the results of the 1st round of questionnaires, participants had the opportunity to change their answers.

5.2 Scenario description

For this foresight exercise, the macro dimensions considered to be most relevant in urban sustainability evolution were *climate change*, *energy and technological development*, and *economy*. Three scenarios were constructed based on assumptions on the evolution of these macro dimensions: *BRIDGE in Wonderland*, *Climate change is a burning issue* and *Lack of energy in freezing the economy*.

The scenarios are presented as a story, with two main components:

i) a general picture of the world in 2030, where the main international drivers are pointed out;

ii) the major consequences of those drivers, at the urban level.

They represent extreme possible futures, and were presented in an informal manner, using strong, representative and clear pictures (some are included here, as examples).

Scenario I
BRIDGE in wonderland

Scenarios	Climate Change	Energy / Technological Development	Economy
1	+	+	+
2	-	+	+
3	+	-	-

The world in 2030: overview

- Gradual transition to renewable energy sources
- Efficient use of energy
- Cleaner uses of fossil energy
- Low level of climate change
- Socially balanced society
- Highly productive economy

- Easy transition towards alternative energy sources:
  - Fossil energy is still available
  - New energy sources are steadily increasing
  - Energy is produced and used efficiently
  - Revolutionary techniques reduce the threat of climate change

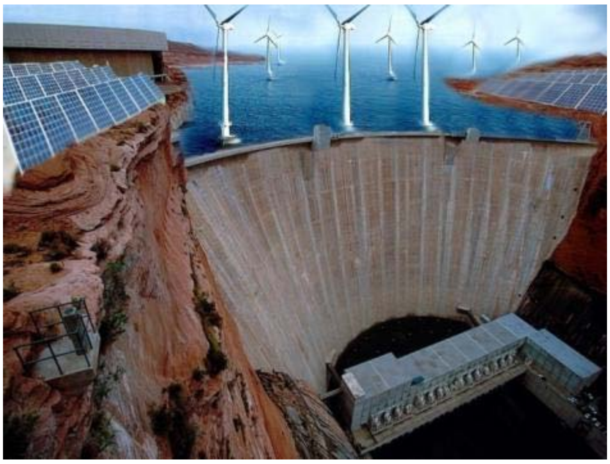

Figure 1A. Picture from the 1st scenario

- High mobility
  - Innovative public transport is gaining importance
  - Accessibility is a key issue to cities' attractiveness
  - ICT development improve the balance between computer mediated communication and personal interaction

- Efficient water use
  - Use of diversified sources and rational consumption

- Social cohesion

Key urban issues
Cities' success depends on their ability to attract qualified people and firms

- Rational urban planning
  - The quality of urban design is not constrained by major economic or environmental restrictions
  - Buildings are concerned with aesthetics, functionality and environmental quality
  - Center-periphery dichotomy is mitigated

- Strong competition among cities (as a consequence of high mobility)

- Cities try to improve their advantages and to reduce their drawbacks
  - Big cities
    - Improved accessibility
    - Reduced environmental problems
    - Recovered neglected historic and industrial neighborhoods
  - Medium sized cities
    - Networks
    - High quality services and infrastructure
    - Key investments as drivers for cities' dynamism

Figure 1B. Pictures from the 1st scenario

Scenario II

Climate change is a burning issue

Scenarios	Climate Change	Energy / Technological Development	Economy
1	+	+	+
2	-	+	+
3	+	-	-

The world in 2030: overview

- Energy is not that big a problem
- Economy is growing
- Climate change is a serious threat
- It is absolutely necessary:
  - To cut greenhouse gases (GHG) emissions
  - To absorb GHG already in the atmosphere

- Climate change is very significant
  - Global warming is occurring much faster than expected
  - Extreme events happen more regularly

- Water is becoming a rare resource
  - Rational consumption is a major concern
  - Considerable investment for re-using urban water
  - Conflict between different uses of water

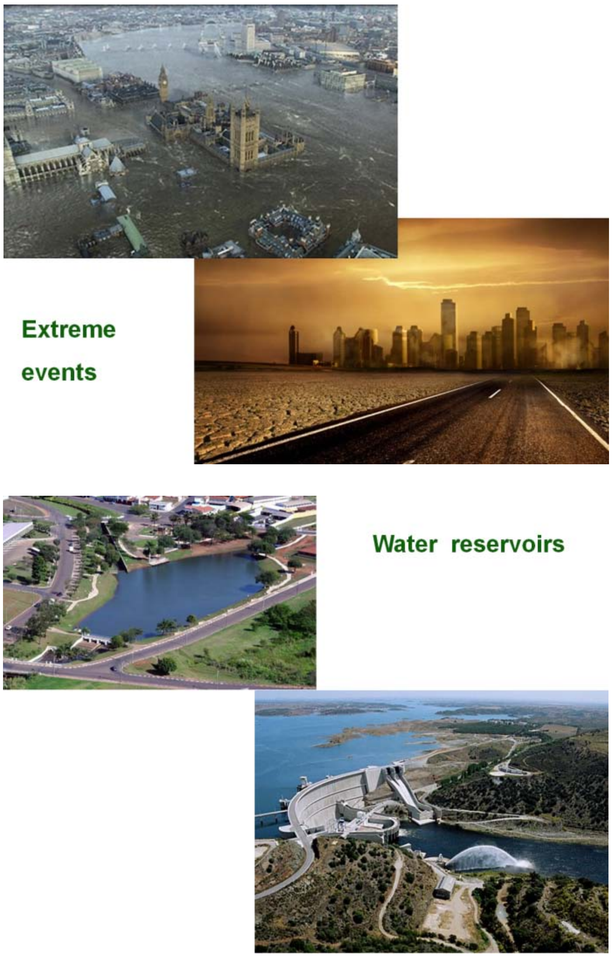

Figure 2A. Pictures from the 2nd scenario

- Several mechanisms for climate change control are developed
  - High investment on climate change related R&D
  - High investment on mitigation strategies
  - High investment on adaptation strategies

- Energy production
  - Expansion green energy sources
  - Limitation on the use of carbon fuels
- Transport
  - Development of transports with low carbon emissions
- Social cohesion
  - Investment in mechanisms to prevent climate change still leaves resources for high quality consumer goods and services

CORRIERE DELLA SERENATA

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25% of the FP10 will be used for climate change adaptation strategies

UNA SOCIETÀ APERTA

«Qui tutto è possibile»

«Ora giusto aiutarlo»

Quando era lecito linciare i neri

Alabama, tra i vinti al bar dei bianchi

Il padre poligamo e la madre giramondo

Michelle la dura, astronauta mancata

Key urban issues
Cities' attractiveness depends on their capacity to face climate change

- Vertical growth of urban centers
- Measures to reduce urban heat islands and pollution
  - Increase of thermal efficiency
  - Use of recycled and reused materials
- Measures to cope with floods and sea level rise
  - Spread of flood control mechanisms
  - Spread of buildings that adapt to rising waters
  - Heavy regulation on construction

Figure 2B. Pictures from the 2nd scenario

Scenario III
Lack of energy in freezing the economy

Scenarios	Climate Change	Energy / Technological Development	Economy
1	+	+	+
2	-	+	+
3	+	-	-

The world in 2030: overview

- Energy shortage
  - Non-renewable sources are reaching the end
  - Use of renewable sources is insufficient
- Reduced mobility leads to urban concentration
- Resources are diverted for fast increase of renewable energy sources
  - Less resources for consumption
  - Increased social inequality

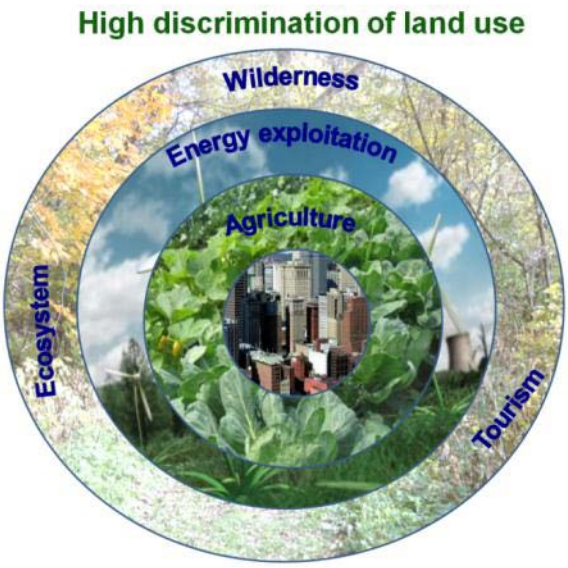
The end is neigh… for fossil energy!

- Fossil energy sources are almost depleted
- Available alternative energy sources are not enough
- Because of energy shortage and economic distress environment is a low priority

- Anything is good:
  - To produce energy
  - To avoid energy consumption
- Low mobility
  - Individual hard modes of transportation are marginal
  - Vehicles with limited or no energy consumption are booming
  - Activities are structured around main arteries and collective transport hubs
  - ICT is a substitute for physical mobility

Figure 3A. Pictures from the 3rd scenario

- <u>High R&D investment in new energy sources and production of energy:</u>
  - Diverts resources from the production of consumer goods
  - Decreases salaries in relation to capital revenues
  - Increases social inequalities
  - Increases spatial segregation by income
- <u>High discrimination of land use according to distance to markets</u>



Key urban issues:
Cities' success depends on low costs

- <u>Population is concentrated in high density urban centers</u>
- <u>Housing comes back to inner cities</u>
  - Cheap construction

Figure 3B. Pictures from the 3rd scenario

5.3 Scenario Analysis – thematic debate

The participants were divided into three groups, with the goal of defining urban policies that would lead to a sustainable city, in each one of the scenarios. Urban sustainable planning has, in our opinion, three dimensions: a physical manifestation – urban design, an environmental component, conditional to energy availability, and also an economic component (urban attractiveness). Each group focused on a different theme.

Thus, the chosen themes were:

1. *Urban design*
   Trade-off between quality of public space / housing and sustainability of urban metabolism
2. *Urban attractiveness*
   Urban attractiveness: trade-off between capacity to attract qualified firms and people and the constraints of sustainable development
3. *Sustainability in energy consumption and production*

Trade-off between energy availability/physical accessibility and the constraints to sustainable supply of energy

In each round table, two main questions guided the debate (these will be presented in the corresponding sub sections 5.31, 5.3.2 and 5.3.3). The participants were asked to answer them, trying to focus on the differences between them the scenarios, as well as on some strategies that might be prolific for all of them.

In the following pages, a short description of the ideas discussed can be found.

5.3.1 Urban design

This round table was constituted by:

Facilitators Ainhoa González (TCD)
Marta Marques (UAVR)

Participants Afroditi Synnefa (NKUA)
Alex Nickson (Greater London Authority)
Alpo Tani (Helsinki City Planning Department)
Eddy Moors (ALTERRA)
Justyna Gorgon (IETU)
Malgorzata Knebloch (Gliwice City Hall)
Margaretha Breil (CCMC)
Nicholas Zervoglos
Peter Freer-Smith (SOTON)
Pietro Toscano (CNR)

The debate was oriented by the following questions:

What will the built environment be like under each scenario in terms of materials, layout and open spaces?

What kind of transport will be prioritised? How will transport infrastructure be organised?

The idea that was implicit in the debate was that urban infrastructures, being transport infrastructure only one of them, are essential in the ability of a city to respond to changes, and so they should be as flexible as possible in all scenarios.

Scenario I

Built environment

In this scenario, the only concern is the sustainable development of the cities. So, one of the natural consequences of an absence of economic and energetic constrains is the enlargement of urban areas (increase in land consumption, as well as other resources). This has different effects on different urban centres: in bigger cities, like Helsinki, sprawling would increase and in small or medium size cities, like Gliwice, polycentric development will be enhanced.

The economic conditions together with the desire to protect the environment lead to constant infrastructure innovation. The technological development is no longer a way to fix problems: problems are anticipated and resolved before affecting communities. One example of the changes that are done regarding infrastructure is introduction of grey water recycling systems, both for individual building and urban settlement.

In the same line, construction plans are more flexible, allowing buildings and neighbourhoods to adapt to different uses over time, responding to a rapid evolving world. Architecture and urban

planning would also have to respond to the need for original sustainable design in buildings and neighbourhoods.

The protection of the surrounding landscape was also pointed out as an important measure as the landscape is now seen as an important resource (people value it as an amenity).

Urban sustainability was described as an attractiveness factor, important for the city development. Thus it is incorporated in all urban policies.

Transport (and its impact on urban design)

Transport corridors would be changed: usually, roads and other transport corridors segregate urban space; in this scenario they are giving other functions (e.g. green spaces), integrating them in the urban space. The increased efficiency characteristic of the scenarios leads to an improved public transport system and also to car-hire/car-sharing solutions, in order to reduce the domain of public car in the inner cities, creating more space for nobler uses.

Scenario II

Built environment

The main issue in this scenario is mitigation of GHG emissions and adaptation to climate change. A balance between built up areas and green spaces within cities was a proposed measure, as it increases their response capacity to weather extreme conditions (e.g. increase in temperature, flooding).

In some cities, the main issue would be implementation of flood defences. Thus, some measures were proposed, with high or low technological component:

- metropolitan underground systems, and certain city roads, could be adapted to temporary water channels, in a flood risk situation, leading it away from the city;
- rainwater collection in roofs (green roofs or other sustainable urban drainage systems - SUDS).

Urban infrastructures are upgraded, increasing their efficiency (in what concerns water and energy usage), as well as their resilience to extreme events, heat or water related. Buildings design will not be in the top of priorities: it is more important to save resources to invest in climate change issues.

Increased importance is recognized in urban regulations (e.g. on soil sealing and SUDS), which are stricter and more carefully implemented.

Transport (and its impact on urban design)

As already mentioned, public transport systems can have an important role in adaptation to extreme weather conditions. Underground public transport networks and car-parking infrastructures have the potential to act as flood storage and drainage infrastructure.

The transport infrastructure as a whole would have to be signalled, indicating emergency procedures (e.g. emergency exits), as a response to the increase frequency of extreme weather events.

The spread of office hours would be another simple measure that would reduce the peak use of public transport systems, and increase its capacity. Road use and parking would also be more heavily taxed, in order to discourage use of private cars.

Scenario III

Built environment

In a scenario where energetic scarcity is the main driver, urban space (with high accessibility) becomes itself a scarce resource. Examples of important measures would be:

- retrofit of old builds (increasing their energetic efficiency and production capacity), protecting those with cultural and historical importance,
- space recycling (e.g. removing energetic inefficient buildings and rebuilding these areas),
- building orientation to consider solar exposure (taking also into consideration pollutants dispersion),
- roofs with photovoltaic panels and other renewable energy production options,
- building materials that optimise energy efficiency (adapted to different meteorological needs, e.g. Athens and Helsinki).

Reduction of transport needs is also a major concern, thus urban spaces became more concentred, and with a high functionality mixture, taking advantage of the high accessibility that characterizes the city centres. Measures that contribute to reducing of transport needs would include:

- implementation of a home working culture,
- creation of micro-offices in the neighbourhoods, where people from different firms can work, sharing office resources,
- conversion of urban green spaces into agriculture fields,
- urban development around transport nodes.

There is an increased importance of urban regulations (e.g. on energy efficiency and renewable production): they are stricter and more thoroughly implemented.

Urban design is not important at all: it would be necessary to save resources in order to invest them in the energetic issues.

Transport (and its impact on urban design)

The lack of energy naturally implies measures to promote the soft modes of transport, walking and cycling, and to optimize the urban public transport system, increasing its capacity while reducing its energy consumption. Actions to inhibit the use of private transport are implemented (e.g. limits to road use through a permit system, related to the vehicle type).

Another measure proposed concerned the transport of goods: the segregation of transport through the provision of hubs for redistribution would reduce the number of vehicles in city centres and the number of trips necessary to distribute the goods to shops. The development of the transport networks would also increase efficiency in energy consumption.

Technological evolution in transport is encouraged, and it would result in increased availability and use of decarbonised energy fuelled public and private vehicles.

These main ideas are summarized in Table 2.

5.3.2 Urban attractiveness

The round table on urban attractiveness was constituted by:

Facilitators	Annemarie Groot (ALTERRA)
	Jan Wolf (UAVR)
Participants	Alexandros Karvounis
	Carlos Rodrigues (UAVR)
	Katarzyna Kobierska (Gliwice City Hall)
	Paulo Pinho (FEUP)
	Sue Grimmond (KCL)

Table 2. Main ideas of the debate on Urban Design

	Scenario I	Scenario II	Scenario III
Built environment (materials, layout and open spaces)	▪ Urban sprawl (big cities) / Polycentric decentralized urban centres with mixed use (medium and small cities) ▪ Protection of the surrounding landscape (provision of amenity) ▪ Flexibility of the construction plans (i.e. adaptation to varying uses over time for buildings and neighbours) ▪ Infrastructure innovation ahead of development ▪ Grey water recycling within developments	▪ Rainwater collection in roofs (green or other sustainable urban drainage systems - SUDS) ▪ Upgraded infrastructures – increased efficiency (water, energy) ▪ Floods control systems (roods as underground as temporary water channels) ▪ Increase building resilience (adaptation to extreme events) ▪ Stronger regulations (e.g. soil sealing and SUDS)	▪ Compact and high density urban form, particularly around transport nodes ▪ Retrofit historic building / remove non-efficient buildings if retrofit not feasible ▪ Building orientation to consider solar exposure ▪ Home working / micro offices in the neighbourhoods ▪ Roofs with photovoltaic panels and other renewable energy options ▪ Building materials that optimise energy efficiency ▪ Urban spaces for urban agriculture, allowing to harvest local crops
Transport organization and infrastructure	▪ Transport corridors not separating the urban space ▪ Improved public transport and car-hire/car-sharing solutions	▪ Segregated transport (through the spreading of working hours) ▪ Underground public transport networks and car-parking (potential for flood storage) ▪ Signalling of emergency exits on roads and public transport (extreme weather events) ▪ Maximise taxation to discourage use of private cars	▪ Develop existing transport networks ▪ Optimized urban public transport system ▪ Increase in walking and cycling ▪ Segregation of transport through the provision of hubs for redistribution (particularly for transporting goods) ▪ Limitations on road use (e.g. permits depending on vehicle type) ▪ Increased availability and use of decarbonised energy fuelled vehicles

This debate was oriented by the following questions:

1. Which type of human resources and industries future cities need to attract?
2. What policies should be developed by cities in order to attract the kind of human resources and firms that were considered crucial?

Implicit in this discussion was also the potential tradeoff between attractiveness, availability of urban funds and urban metabolism.

Scenario I

Type of industries and human resources

In this scenario, abundant resources and high mobility lead to high competition among cities.

Two main tendencies were identified. On one hand, high levels of general well-being can lead to a conservative attitude of cities. Their urban planning could thus be concerned with stability and gate-keeping strategies instead of with growth and attracting new firms and human resources. On the other hand, and while some cities might be able to take advantage of their position, others still need to reinvent themselves and so have to exploit their competitive advantage.

In either case, since basic needs are satisfied, a city's distinctiveness is considered to be determined by the opportunities it provides for personal fulfillment. So the economic sectors which play a major role in this scenario are the ones linked to culture and other immaterial aspects. Therefore crucial professionals are cultural animators, chefs or creative highly skilled workers.

Measures to attract the human resources and firms

The strategy for attracting the desired kind of resources is to build on what is already there. Many of the needed skills are therefore developed endogenously (qualification of local labour markets), and in fields in which the cities already have a competitive advantage. For example, Athens should try to focus on culture and tourism, attracting professionals in sectors such as arts, hotel management or cultural animation. Gliwice should try to take advantage of its higher education institutions, and so forth. But all of them would have to develop strategies to address issues such as culture and leisure opportunities, on an infrastructural as well as a material level:

- Valuing of build cultural heritage (e.g. monuments);
- Development of a dynamic cultural sector;
- Fostering of creative industries;
- Marketing of regional goods.

Scenario II

Type of industries and human resources

The measures to mitigate, adapt to and prevent further climate change create a technological driven society. Simultaneously there is a conflict between the need for resources, on one hand, and the need for environmental protection, on the other hand. There is a strong public sector that coordinates mitigation and specially adaptation strategies to the menaces posed by climate change (since safety issues tend to be seen as a predominantly public mater). The public sector is also responsible for coordinating national, regional and international planning mechanisms (since climate change affects entire trans-border regions).

Economic sectors linked to environmental protection are growing, leading to the rise of firms related to:

- Big engineering projects;

- Equipment for reuse and recycling;
- Climate change related R&D (e.g. new materials and technologies).

The valued human resources in this scenario are:

- Environmental scientists;
- Engineers;
- Qualified civil servants.

Measures to attract the human resources and firms

The attraction of the needed enterprises and human resources depend on:

- The establishment of a strong public sector that is able to organize local strategies (although there must be global funding system);
- Tax incentives for enterprises that produce in sustainable ways and that develop climate change related R&D;
- Tax penalties for heavy polluters;
- Public campaigns to increase awareness.

Scenario III

Type of industries and human resources

Reduced mobility leads to the rise of local production and distribution systems, and also to the valuing of primary goods. Thus, infrastructures tend to be more developed on an intra-regional, rather than a national or international level, and local governments assume some of the functions that were traditionally assumed by central governments. The rising importance of the community level is further increased by a growing third sector that contributes to mitigate some of the more extreme consequences of high social inequality (welfare communities as opposed to welfare state).

In this scenario the type of firms that cities want to attract are concerned with:

- Energy production
- Third sector services
- Communications

The low specialization of the economic sectors and local production of goods, leads to the valuing of human resources that are multi-functional, multi-tasking and multi-talented.

Measures to attract the human resources and firms

The main development strategies are concerned with a greater self-sufficiency of local communities:

- Local efficient transportation;
- Cheap concentrated housing;
- Economic sector related to energy production;
- Communication systems (function as a substitution of physical interactions: less concrete, more fiber);
- Encouraging local innovation.

A robust strategy for all three scenarios is the valuing of "bridge professionals" that are able to establish a link between different fields of expertise.

These main ideas are summarized in Table 3.

Table 3. Main ideas of the debate on Urban Attractiveness

	Scenario I	Scenario II	Scenario III
Type of human resources	▪ Cultural animators ▪ Chefs ▪ Creative highly skilled workers	▪ Environmental scientists ▪ Engineers ▪ Qualified civil servants	▪ Human resources are multi-functional, multi-tasking and multi-talented
	"bridge professionals" that are able to establish a link between different fields of expertise		
and industries the cities of the future will need	▪ Creative industries	▪ Climate change related economic sectors: - Big engineering firms - R&D ▪ Strong public sector (adaptation & mitigation measures)	▪ Increase of economic sectors linked to energy production ▪ Greater role for local firms in satisfying population needs
Measures to attract the human resources and firms	▪ Take advantage of cities' distinctiveness ▪ Valuing the build cultural heritage ▪ Development of a dynamic cultural sector ▪ Develop skills endogenously (qualification of local labour markets)	▪ Strong local public sector that is able to coordinate adaptation and mitigation strategies ▪ Increased integration of planning mechanisms (at a regional, national and international level) ▪ Mechanisms to attract sustainable firms (e.g. tax incentives and penalties)	▪ Development of local production systems (reduce transportation) ▪ Strong development in: - Local efficient transport systems - Cheap concentrated housing - Communication systems - Energy production

5.3.3 Sustainability in energy consumption and production

The round table on sustainability in energy consumption and production was constituted by:

Facilitators · Myriam Lopes (UAVR)
Monique Borges (UAVR)

Participants Carlos Borrego (UAVR)
Laine Ilkka (Helsinki City Planning Department)
Leena Jarvi (UHEL)
Marcin Czyz (Gliwice City Hall)
Mathew Thomas (Greater London Authority).
Nektarios Chrysoulakis (FORTH)
Nick Hodges (BRIDGE Advisory Committee)

The objective of this thematic round table was to discuss urban policies for each scenario. To guarantee sustainable energy consumption and production it is essential to understand how policies impact urban realities, and how to define a framework for more specific policies regarding thermal comfort and sustainable energy supply.

This debate was oriented by the following questions:

1. How to ensure thermal comfort with a rational investment in energy, in what regards heating and cooling?
2. How will urban policies deal with energy production, distribution and consumption?

The first considerations raised questions concerning different measures from the public and private sectors and the need of a territorial analysis. The intervention on built urban areas was considered as an important aspect in all kinds of measures to be proposed in this field. In some cases, it might mean increasing buildings efficiency, but in orders it could lead to the destruction of existing buildings.

Scenario I

Thermal comfort

For the first scenario, the most important measure for increasing thermal comfort was considered to be the implementation of technical regulations for energy efficiency. Since there are no economic and environmental constrains, intelligent houses with sophisticated control systems should be developed. These houses would take advantage of external environment conditions for the assurance of internal thermal comfort. In this context, insulation is a major issue, for its capacity to reduce or increase heat loss and the subsequent impact on energy demand for heating and cooling systems.

On the other hand, historical heritage might be affected by the attempt of increasing energy efficiency. In order to ensure cultural meaning in housing renovation process, the new standards associated to urban technical regulation must deal specifically with old buildings (for which regulations should be more relaxed). So energy efficiency and thermal comfort are combined with building design.

Energy supply

As in the previous section, also in what concerns energy supply, building design should be changed. The combination of technological development and design is one of the characteristics of this scenario: innovative buildings that are almost self-sufficient regarding energy will be developed.

Alternative and traditional energy sources should be explored in urban areas in order to achieve maximum energy production (efficiency in the productive process) and also thermal comfort, e.g. implementing centralized heating systems that would also produce electricity.

In spite of the stability in the first scenario, urban decisions must have a strong technical basis, to allow a sustainable urban growth.

Scenario II

Thermal comfort

In the second scenario climate change is the main concern, so urban policies need to face the consequences and to prevent the worsening of the problem. As a consequence, experts mentioned the need to incorporate adaptation measures in urban policies, such as changes in construction materials, in order to maintain interior temperature. Thus other local solutions should be adopted, such as an increase of trees (shading), cool roofs and rain reservoirs. The existence of cool spots, distributed in city centres, should also be guaranteed to face heat waves.

Energy supply

One of the topics of the debate was how to combine decentralized energy production and storage. The increase of the buildings' energetic efficiency was also mentioned in this topic, but focusing also on energy storage technologies and on a decrease in consumption. There are no strong economic constrains, so one way to face climate change is to renovate houses in order to include technological innovations, increasing energy supply and also thermal comfort, without negative environmental impacts. Recycling centres (for materials and water) should also be increased, so as to diminish energy usage, air and water pollution and conventional waste disposal, resulting in lower GHG emissions. Production systems, as strong energy consumers, have a strong negative impact on the environment and on GHG emissions. It is essential to change production technologies and also to accept nuclear energy as an alternative which will increase GHG free energy production.

Scenario III

Thermal comfort

In the third scenario, according to the negative aspects imposed by economic and energetic instability, urban policies aim at an increase in energetic efficiency. This means that buildings' efficiency is a priority and so natural or passive cooling and ventilation systems must be implemented, such as evaporative cooling and air circulation to enhance comfort, assuring Summer and Winter cooling at low costs. Vegetation and solar control are two solutions recommended. Vegetation (urban agriculture) is considered to be essential for outdoor spaces, to improve atmospheric environment, reduce cooling and also food transport. On the other hand, solar control allows simple heat protection systems, where techniques should be developed in order to prevent entrance of solar radiation, or direct sunlight, reducing the need of energy consumption for cooling. A consequence of the mentioned interventions on buildings is the decrease of their aesthetic value, which is neglected in favour of buildings' efficiency.

Energy supply

Experts consider that space must be rationalized according to energy production and food supply requirements, where urban agriculture plays a significant role (reducing transport, as already mentioned). Moreover, renewable energy exploitation and energy consumption cutback lead to a BMW (Bicycle, Metro, and Walking) approach to face energy scarcity. Building's energy efficiency is seen as a way to provide thermal comfort, but also to reduce energy consumption. It was suggested that the energy stored as heat in buildings, which is usually seen as inefficiency, should be used as an energy source: building construction materials absorb heat during the day, controlling indoor temperature, and during the night that energy would be used in heating.

Waste incineration was pointed out as a desirable form of disposal: waste becomes an energy source.

These main ideas are summarized in Table 4.

Table 4. Main ideas of the debate on sustainability in Energy Consumption and Production

	Scenario I	**Scenario II**	**Scenario III**
Thermal comfort	▪ Intelligent houses ▪ Building insulation is an essential issue ▪ Relaxed restrictions(e.g. housing renewal, when cultural values are involved)	▪ Adaptation measures are a priority (e.g. tree shading, green spaces increase, cool roofs, rain reservoirs) ▪ Cool spots distributed in cities (to face heat waves)	▪ Natural or passive cooling and ventilation systems ▪ Buildings' aesthetics is neglected in favour of buildings' efficiency
Energy production, distribution and consumption	▪ Combination of building design and new energy technology ▪ Mixed energy use (different sources) ▪ Technical component has a strong influence in urban decisions	▪ Decentralized energy production ▪ Technology development to increase energy supply (housing renovation) ▪ Recycling centers (greater efficiency in materials and water use) ▪ Acceptance of nuclear energy	▪ Urban agriculture (less energy consumption in transport) ▪ Renewable energy exploitation and energy consumption cutback ▪ BMW approach (Bicycle, Metro, Walking) ▪ Waste incineration

5.4 Scenario Analysis and preferences related to planning alternatives: case study discussion and Delphi questionnaire

The ideas arising from the debate were reflected on the questionnaire answers, and thus only a quantitative analysis of the afternoon session is made in this report.

The objective of this questionnaire was to understand the variability of the relative importance of the different criteria and indicators used in BRIDGE DSS, and to see how such variability affects the selection of the best alternative.

The environmental and socio-economic criteria and indicators chosen for this exercise are a subset of all indicators included in BRIDGE DSS (see Annex A1). Some extra socio-economic indicators were also included, in order to reflect specific characteristics of each project. They were grouped in four main categories corresponding to main concerns in urban planning.

In each round table, there was a brief presentation of the case study to the participants not familiar with it, followed by a debate about the main priorities concerning urban policy, in the three scenarios.

As indicators were grouped in four main categories (physical environment, energy and thermal comfort, land use / urban design and economic viability), participants were asked to prioritize each of these categories and to explain their reasons to do so. Afterwards, the first questionnaire was filled out, focusing on the relative priority attached to the dimensions and indicators related to the case study in question. The debate continued on the relative importance of the different indicators in each case study: local experts exchanged opinions on their answers.

Results of the fist questionnaires were presented at the end of the afternoon, and afterwards participants had the opportunity to change their answers.

It is necessary to recall that BRIDGE evaluation formula is based on scores and weights (section 3.3): scores reflect the relative performance of the planning alternative under evaluation when compared to a reference situation; weights define the relative importance ascribed by the end-users to each indicator.

The scores were calculated before the exercise: estimations were made, with the collaboration of BRIDGE elements responsible for the case studies (in all case studies) and of local experts (only for Athens, Helsinki and Gliwice). It should be noted that real scores are not available, mainly because the modeling process is not yet finished (annexes 3, 4 and 5 show the scores for Athens, Helsinki and Gliwice).

The weights were calculated as an average of the standardized values of the participants' answers (in annexes 3, 4 and 5 it is possible to see the weighs, for the 1st and 2nd round of the questionnaire, for the three scenarios, for Athens, Helsinki and Gliwice).

The final output measures the relative advantage of implementing a certain planning alternative when compared with the reference situation (in most case studies, the first alternative was chosen as reference). Results are presented only for Athens, Helsinki and Gliwice. In the London case, the planning alternatives were changed during the debate, making the previously prepared scores inappropriate for the corresponding evaluation.

5.4.1 Athens

The round table had the following participants:

Facilitator	Zina Mitraka (TCD) Eduardo Castro (UAVR)
Participants	Afroditi Synnefa (NKUA) Alexandros Karvounis Pietro Toscano (CNR) Nektarios Chrysoulakis (FORTH) Nicholas Zervoglos

In the Athens case study, the three planning alternatives being considered are related to the Egaleo municipality. They are quite different from each other, and it is impossible to compare them between themselves, since several indicators are not applied to all alternatives (e.g. one cannot compare the increase in new inhabitants between the alternatives 1 and 2, since in the first one there is no increase in inhabitants). Therefore the adopted reference situation in the Athens case is a scenario where no intervention is made.

Main goal: increase thermal comfort.

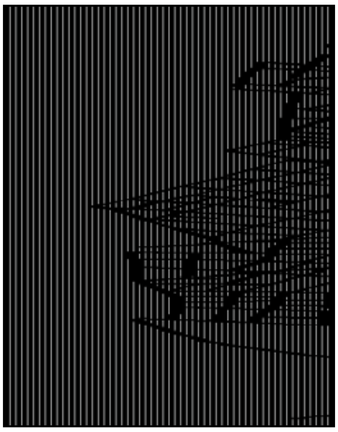
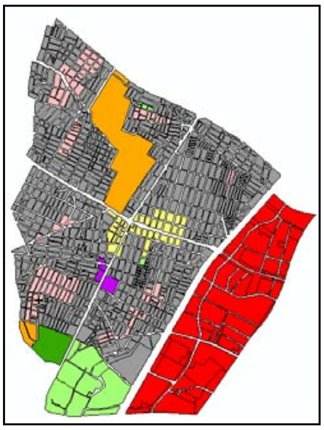
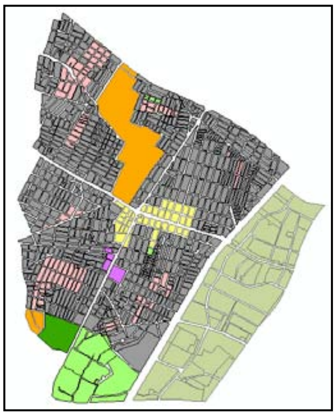
Complementary goals

- to reduce heat island effect,
- to decrease air pollution,
- to increase energy efficiency,
- to enhanced quality of life,
- to improve human health.

Planning alternative 1	Apply cool materials on all buildings at Egaleo municipality and on roads.
Planning alternative 2	Change the land use of Eleonas (an industrial area of Egaleo) from brownfield area to built environment.
Planning alternative 3	Change the land use of Eleonas from brownfield area to green space.

In the following tables, PA stands for planning alternative and S for scenario.

Table 5. DSS results, for the three scenarios, on the 1st and 2nd round, concerning the Athens case study

	DN*	PA I		PA II		PA III	
round		1st	2nd	1st	2nd	1st	2nd
S I	1,00	1,17	1,20	1,08	1,13	**1,18**	**1,21**
S II	1,00	1,16	**1,17**	1,12	1,13	**1,17**	**1,17**
S III	1,00	**1,12**	**1,16**	1,04	1,09	1,10	1,14
							

*Do nothing scenario

The first conclusion is that, for all scenarios, any alternative is considered better than doing nothing (all final results are higher than 1). The values given to alternatives 1 and 3 are quite similar.

Alternative III, related to aesthetics and post-materialist drivers, is preferred in the optimistic scenario, while alternative I becomes more important when climate change or lack of energy become key issues. In any case, the small difference between alternatives I and III mean that a more precise and detailed analysis is required.

Table 6. Average standard deviation of the questionnaires' answers, grouped by dimensions, on the 1st and 2nd round, concerning the Athens case study

	S I		S II		S III	
	1st	2nd	1st	2nd	1st	2nd
Dimensions	0,065	0,057	0,075	0,057	0,098	0,051
Physical Enviorment	0,100	0,096	0,070	0,071	0,100	0,092
Energy / Thermal comfort	0,085	0,071	0,024	0,031	0,129	0,129
Land use / Urban Design	0,056	0,062	0,100	0,100	0,076	0,069
Economic viability	0,118	0,163	0,064	0,090	0,017	0,033

Note: green stands for decreases of variability bigger than 20% and red stands for increases of variability bigger than 20%.

The reasons why participants were invited to change their answers was to find out if the debate with other participants and the presentation of results had any impact on their own opinions. In the Athens case, Table 5 shows that the changes were small. Table 6 indicates the standard deviations of answers; the first row refers to weights ascribed to the four dimensions while the remaining rows show standard deviations for weights inside each dimension.

Results show that the discussion generated a consensus process concerning the relative importance of the dimensions. However, such consensus did not apply to weights inside each dimension. This interesting outcome indicates that while broad dimensions are a much clearer basis for discussing and forging a collective opinion than detailed indicators which require a more sound technical background.

5.4.2 Helsinki

The round table had the following participants:

Facilitators .	Myriam Lopes (UAVR) Monique Borges (UAVR)
Participants	Alpo Tani (Helsinki City Planning Department) Carlos Borrego (UAVR) Eddy Moors (ALTERRA) Laine Ilkka (Helsinki City Planning Department) Leena Järvi (UHEL) Paulo Pinho (FEUP) Timo Vessala (UHEL)

The Finish case study focuses on three alternative residential areas, in a green area of the city of Helsinki, in the Meri-Rastila suburb.

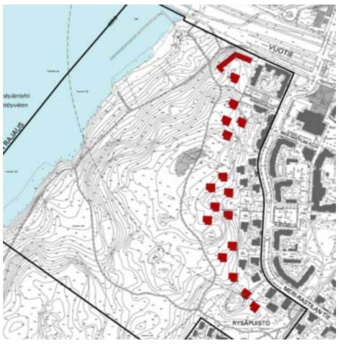
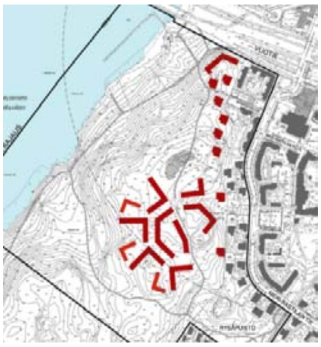
Main goal: Increase of urban density within the walking distance of Rastila metro station (600 m radius) by creating new housing and workplaces, balancing the provision of green and built areas.

Complementary goals

- to minimize traffic based energy consumption and carbon dioxide emissions;
- to develop a more balanced community and dwelling stock by building more owned dwellings and bigger apartments;
- to maintain or increase services in Meri-Rastila;
- to maintain sufficient amount of green area and possibilities for outdoor recreation.

Planning alternative 1	Construction of buildings for 500 inhabitants.
Planning alternative 2	Construction of buildings for 1500 inhabitants.
Planning alternative 3	Construction of buildings for 1800 inhabitants and 1000 new jobs.

Table 7. DSS results, for the three scenarios, on the 1st and 2nd round, concerning the Helsinki case study

	PA I		**PA II**		**PA III**	
round	1st	2nd	1st	2nd	1st	2nd
S I	**1,00**	**1,00**	**1,00**	0,99	0,99	0,98
S II	1,00	1,00	1,08	1,10	**1,10**	**1,12**
S III	1,00	1,00	1,14	1,14	**1,16**	**1,15**
						

The planning alternatives for Meri-Rastila presented similar performances in the three scenarios. When there are no economic or environmental constraints scenarios, the results for the three are almost equal: there are no clear gains of increasing the constructed area. In the second and third scenarios, the results point to the project with more inhabitants and built up area (planning alternative III), but with a marginal advantage over planning alternative II. The second round of answers did not bring significant changes to the average results.

Table 8. Average standard deviation of the questionnaires' answers, grouped by dimensions, on the 1st and 2nd round, concerning the Helsinki case study

	S I		**S II**		**S III**	
	1st	2nd	1st	2nd	1st	2nd
Dimensions	0,060	0,064	0,081	0,046	0,084	0,055
Physical Enviorment	0,054	0,057	0,045	0,081	0,096	0,049
Energy / Thermal comfort	0,192	0,192	0,078	0,098	0,133	0,160
Land use / Urban Design	0,065	0,067	0,058	0,085	0,076	0,092
Economic viability	0,065	0,066	0,072	0,073	0,026	0,016

Note: green stands for decreases of variability bigger than 20% and red stand for increases of variability bigger than 20%.

In the Helsinki case, the comparison between the first and second round leads to the same conclusions as those pointed out for the Athens case study.

5.4.3 Gliwice

The round table had the following participants:

Facilitators	Annemarie Groot (ALTERRA) Jan Wolf (UAVR)
Participants	Anicenta Bubak (IETU) Carlos Rodrigues (UAVR) Justyna Gorgon (IETU) Katarzyna Kobierska (Gliwice City Hall) Malgorzata Knebloch (Gliwice City Hall) Marcin Czyz (Gliwice City Hall) Margaretha Breil (CCMC)

In Gliwice, the construction of a new road increased the accessibility of the Polytechnic district, as well as the attractiveness and sustainability of improving the infrastructures in this area. Several projects are being considering. The ones considered in this exercise represent a intervention in a area now occupied by a small sports zone, old industrial premises and some green spaces)

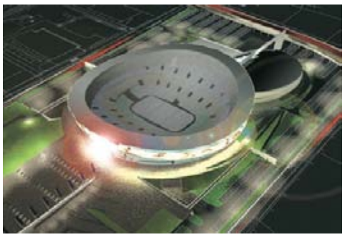
Main goal: rehabilitation project, aimed to take profit from a new motorway.

Complementary goals

- creation of a innovative economic structure,
- improvement of quality of life,
- development of metropolitan functions (in the context of the Silesian Agglomeration- composed by 14 cities),
- reinforcement of the public space attractiveness ,
- empowerment of civil society (governance).

Planning alternative 1	Construction of a Sports Centre.
Planning alternative 2	Construction of a Centre for New Technologies.
Planning alternative 3	Construction of both a Sports Centre and a Centre for New Technologies.

Table 9. DSS results, for the three scenarios, on the 1st and 2nd round, concerning the Gliwice case study

	PA I		PA II		PA III	
round	1st	2nd	1st	2nd	1st	2nd
S I	1,00	1,00	1,04	1,01	**1,29**	**1,33**
S II	1,00	1,00	1,03	1,02	**1,04**	**1,05**
S III	1,00	1,00	1,07	1,08	**1,38**	**1,37**
						

The results show that the third alternative is the robust option: whatever the context where the political decision is taken, the best alternative is the construction of the sports and technological centres. Some care should be taken in the interpretation of the 2nd scenario results. In the situation of severe climate change (scenario 2), experts hesitated between doing either the sports centre or the technological centre or both, because neither investment is related to the key interest driven by the scenario.

Table 10. Average standard deviation of the questionnaires' answers, grouped by dimensions, on the 1st and 2nd round, concerning the Gliwice case study

	S I		S II		S III	
	1st	2nd	1st	2nd	1st	2nd
Dimensions	0,094	0,083	0,059	0,059	0,055	0,057
Physical Enviorment	0,079	0,074	0,075	0,072	0,078	0,078
Energy / Thermal comfort	0,145	0,145	0,070	0,058	0,214	0,051
Land use / Urban Design	0,041	0,056	0,062	0,061	0,073	0,066
Economic viability	0,100	0,078	0,113	0,109	0,031	0,031

Note: green stands for decreases of variability bigger than 20% and red stand for increases of variability bigger than 20%.

The comparison of the two rounds shows again the stability of averages results. However, differently to Athens and Helsinki, experts did not improve their consensus on dimensions weights. Such a consensus appeared on the evaluation of the indicators related to energy / thermal comfort.

5.4.4 London

The round table had the following participants:

Facilitator	Ainhoa González (TCD) Marta Marques (UAVR)
Participants	Alex Nickson (Greater London Authority) Nick Hodges (BRIDGE Advisory Committee) Peter Freer-Smith (SOTON) Sue Grimmond (KCL)

In the United Kingdom, the case study is its capital. London faces several environmental challenges, which are on the basis of possible projects that can be selected as BRIDGE planning alternatives.

Because the definition of such projects is still in process, it was not possible to establish precise planning alternatives on time for the foresight exercise. They were only underlined as a collection of actions and goals. This significantly affected the discussion. The intervention area was London Central Activity Zone, the more extensive area in BRIDGE case studies.

Main goal: increase urban green space in Central London, in order to improve air quality and reduce overheating.

Complementary goals

- to mitigate flash flooding,
- to reduce water consumption,
- to decentralize energy production: heating/cooling and power generation.

Preliminary planning alternatives

Planning alternative 1	10% increase of the number of trees (or green area) in Central Activity Zone (planting in sidewalks).
Planning alternative 2	Transformation of 2% of the Central Activity Zone roofs (area) into green roofs.
Planning alternative 3	Implementation of both planning alternatives.

This round table presented some peculiarities. First, three invited experts informed very late that they could not participate, making impossible any substitution. Second, because planning alternatives were still not fixed, the discussion moved quickly to an exchange of opinions, mainly between Alex Nickson and Sue Grimmond, about the best final definition of alternatives. The main goal of GLA was its concern on urban capacity to react to flood situation.

The discussion was very rich in information essential for BRIDGE. The planning alternatives suggested were:

1) to plant a maximum number of trees and to create the maximum quantity of green roofs;
2) to plant an optimum number of trees, and an optimum number of green roofs, according to the study made by KCL;
3) to create the amount of green space necessary to respond to one big flood event every 30 years; this alternative might imply the demolition of built areas, something that is not considered in the previous alternatives.

Before the final definition of alternatives, GLA and KCL still need to deepen the analysis in order to calculate the exact values necessary for the definition of these proposals.

The debate was very useful and interesting but it was a clear deviation of the program objectives. As a consequence, the 1st round questionnaires were filled out without being fully explained and discussed, as in other round tables. Additionally, the change of the planning alternatives made it impossible to use the scores previously prepared. Therefore, there are no numerical results for the London round table.

It must be stressed the importance of the debate on the London case study: the defined methodology was not implemented, but a very fruitful debate was held concerning the definition of the planning alternatives, in a manner that the Great London Authority found them interesting to study, and that BRIDGE DSS could model them.

6. Conclusions

At the end of such a productive exercise, it is difficult to summarize its main findings. Nevertheless, some aspects must be pointed out concerning the several stages of the exercise, its methodology and also the next steps that must be done, in order to take advantage of the work done so far.

Scenario thematic analysis

When a municipality is defining their planning alternatives, this kind of exercise is very useful: it is important to reflect on the aspects that will be determinant to the city, not only in the present, but also in the future, and try to understand how the choices of today will affect the goals of the future.

In the present case, it was emphasized that for energy or climate change constraints, all investments will have to be readjusted. In the absence of environmental, energy and economic constraints, the focus of urban policy would be the prevention of all other types of problems, and the increase of quality of life, in general.

In what concerns the thematic round tables, some robust issues were identified in all:

- efficient use of resources is essential; energy is the key resource but obviously far from being the only one,
- planning must be flexible, both in terms of adopted solutions and decision making processes,
- green spaces play a very important role in urban areas,
- cities' attractiveness is increasingly related to diversity in technical competences and promotion of creativity,
- the governance of the city requires a 'BRIDGE' attitude, linking different technical and scientific areas, as well as liking decision making to multi-criteria tools which combine objective and technical information with scientific knowledge and subjective preferences.

Scenario case study specific analysis – DSS simulation

The first conclusion about the work done for the case studies is that it was important to contribute to the definition of the planning alternatives, either in case as London, where the steps given where very important for the (re)definition of the planning alternatives, or as in Gliwice, where it was possible to gather new information on the socio-economic indicators.

The analysis of questionnaires showed the potential of the DSS, and the way it combines environmental with socio-economic data, subject to different political preferences. It was possible to verify, as expected, that different scenarios lead to different outcomes, ensuring the DSS sensitivity to changes.

The decision making process should always involve the identification of different alternatives, and their evaluation accordingly to different future developments. After reflecting on all future scenarios, the politicians should balance the results and chose one alternative; when the choice is based on solid information and is the same for all alternative contexts, we can be sure that we have a good project for the city. When otherwise, the choice varies with scenarios or there are no clear results, the decision to be taken requires more information about the advantages and

drawbacks of each alternative (namely extra indicators, more accurate values for indicators, rethinking of weights), and about the expected future developments.

For Gliwice, there is a robust alternative which is the best in all scenarios. Conversely, the preferred alternatives both in Athens and Helsinki depend on future scenarios.

In summary, three different cases can be found:

- robust alternatives, which present the best score in all situations;
- unclear evaluation of alternatives, where the scores are very similar, indicating the need to use more and better information;
- unstable results according to the scenarios, which reflects the need to deepen knowledge about future evolution, before a decision is taken.

Another important contribution of this exercise was the reflection about the socio-economic data needed to characterize the planning alternatives, areas that has deserved less attention by BRIDGE.

Methodology

It was also possible to see that most participants were not very familiar with the evaluation process, which in some way, reduced their ability to understand the results presented at the end of the day and, consequently, the potential of the 2nd round of questionnaires. Results also show that the discussion generated a consensus process concerning the relative importance of the dimensions (in Athens and Helsinki). However, such consensus was not verified in weights of indicators inside each dimension. This interesting outcome indicates that while broad dimensions are a much clearer basis for end-users to understand them, and weight them accordingly, indicators are interpreted heterogeneously, since they require a more sound technical background. This will need to be carefully addressed at during the elaboration of the DSS user's manual.

Concerning the results of the sensitivity analysis, it must be pointed out that it proved to be a good choice to regroup the indicators in more well-balanced dimensions, instead of having several environmental criteria, what would naturally reduce the capacity of the DSS to respond to changes in socio-economic variables, and artificially increase the environmental component of the political decision.

It was also possible to conclude, based on the difficulty of the participants to link the questionnaires with the indicators weights, that the pair wise comparison would possibly be a better methodology to do the weight setting, although it is more time consuming.

Work ahead

The data prepared and collected for this exercise continues to be useful for the development of BRIDGE DSS:

- socio-economic scores as well as weights, both on the physical and socio-economic indicators, can be used in other type of simulations;
- the scenarios developed can be adapted by BRIDGE modelers and combined with scenarios provided by institutions, such as International Panel on Climate Change (IPCC); such a combination can mix insights from socio-economic scenarios with more rigorous approaches, arising from scientific forecasts.

It was possible to see that some work still needs to be done in order to meet urban planners' expectations and needs concerning DSS. The interaction between CoP members and BRIDGE team is still of great importance for the project, as it continues to generate inputs, enabling a better design of the DSS.

Nevertheless, it is important to notice the pedagogical value of the foresight exercise for the local experts, as it gave some important clues on how to perform different type of reflection before making a decision on a long-term investment.

It would be desirable to continue the work done with the local experts, in order to apply the DSS in a similar framework, as the decision making process should not be done without considering external restrictions and its consequences in the city's objectives.

Annexes

A.1 Participants list

EXTERNAL EXPERTS	
Nicholas Zervoglos	Member of the evaluation panel of BRIDGE Mid-term Review meeting *architect*
Nick Hodges	BRIDGE Advisory Committee *civil engineer expert on geosciences and environmental issues*
Paulo Pinho	Territory Planning and Environmental Division of the Faculty of Engineering of the University of Porto (FEUP) *expert on environmental impact analysis*
LOCAL EXPERTS	**ATHENS**
Afroditi Synnefa	NKUA (BRIDGE)
Alexandros Karvounis	Independent urban planner
LOCAL EXPERTS	**GLIWICE**
Anicenta Bubak	IETU (BRIDGE)
Justyna Gorgon	IETU (BRIDGE)
Katarzyna Kobierska	Gliwice City Hall, City Development Bureau
Malgorzata Knebloch	Gliwice City Hall, Urban Planner
Marcin Czyż	Gliwice City Hall, City Development Bureau
LOCAL EXPERTS	**HELSINKI**
Alpo Tani	Helsinki City Planning Department
Laine Ilkka	Helsinki City Planning Department
Leena Jarvi	UHEL (BRIDGE)
Timo Vessala	UHEL (BRIDGE)
LOCAL EXPERTS	**LONDON**
Alex Nickson	Greater London Authority
Mathew Thomas	Greater London Authority
Sue Grimmond	KCL (BRIDGE)

BRIDGE EXPERTS	
Carlos Borrego	UAVR *expert on Air Quality models*
Carlos Rodrigues	UAVR *expert on Urban and Regional Economics*
Eddy Moors	ALTERRA *expert on Water models*
Margaretha Breil	CCMC *expert on Climate Change*
Nektarios Chrysoulakis	FORTH *expert on Geographical Information Systems*
Peter Freer-Smith	SOTON *expert on Botany*
Pietro Toscano	CNR *Italian case study representative*

A.2 Indicators used in each case-study evaluation process

Table A1. Indicators chosen for each case study.

	Athens	**Helsinki**	**Gliwice**	**London**
Physical Environment				
GHG emissions	X	X	X	X
Air quality index (legislation standards)	X	X	X	X
Number of inhabitants affected by air pollution	X	X	X	X
Evapotranspiration	X			X
Infiltration			X	X
Potential flood risk			X	X
Energy / Thermal comfort				
Percentage of energy from renewable energy sources			X	
Exterior thermal comfort	X			X
Number of inhabitants affected by heat waves	X			X
Anthropogenic heat loss	X	X		X
Number of inhabitants with access to public transport		X	X	
Land use / Urban Design				
Local green areas (area)	X	X	X	X
New inhabitants	X	X		X
Reclamation of brownfields	X		X	
Access to consumer services		X	X	
Leisure infrastructures (excluding green areas)			X	
Aesthetics	X	X	X	X
Economic viability				
Impact on the economy	X	X	X	X
Cost of the intervention	X	X	X	X
Employment created		X	X	X
Qualified employment created			X	X

A.3 Scores estimate and weights for Athens

Athens	Planning Alternatives				Scenarios					
	Scores I	Scores II	Scores III		WI,1	WI,2	WII,1	WII,2	WIII,1	WIII,2
Physical Environment					**0,20**	**0,29**	**0,26**	**0,30**	**0,23**	**0,18**
GHG emissions	0,85	0,80	0,95		0,22	0,22	0,30	0,30	0,26	0,27
Air quality index	1,00	1,10	0,80		0,25	0,25	0,22	0,21	0,25	0,24
Number of inhabitants affected by air pollution	1,00	2,20	0,80		0,33	0,33	0,20	0,20	0,26	0,25
Evapotranspiration	1,00	1,00	1,10		0,20	0,20	0,28	0,29	0,23	0,24
Energy / Thermal comfort					**0,22**	**0,26**	**0,30**	**0,31**	**0,27**	**0,30**
Exterior thermal comfort	0,60	0,70	0,95		0,37	0,35	0,33	0,33	0,30	0,30
Number of inhabitants affected by heat waves	0,80	0,85	0,95		0,36	0,38	0,38	0,37	0,28	0,29
Anthropogenic heat loss	0,65	0,75	1,00		0,27	0,27	0,29	0,30	0,42	0,41
Land use / Urban Design					**0,35**	**0,26**	**0,24**	**0,22**	**0,20**	**0,19**
Local green areas (area)	1,00	1,30	2,00		0,27	0,28	0,40	0,39	0,29	0,30
New inhabitants	1,30	2,00	1,10		0,21	0,20	0,18	0,19	0,29	0,28
Reclamation of brownfields	1,00	2,00	2,00		0,24	0,23	0,23	0,23	0,26	0,26
Aesthetics	1,50	1,80	2,00		0,28	0,29	0,19	0,19	0,16	0,16
Economic viability					**0,23**	**0,19**	**0,20**	**0,17**	**0,30**	**0,33**
Impact on the economy	2,00	1,50	1,10		0,58	0,65	0,55	0,59	0,50	0,47
Cost of the intervention	2,50	3,00	1,50		0,42	0,35	0,45	0,41	0,50	0,53

A.4 Scores estimate and weights for Helsinki

Helsinki	Planning Alternatives				Scenarios					
	Scores I	**Scores II**	**Scores III**		**WI,1**	**WI,2**	**WII,1**	**WII,2**	**WIII,1**	**WIII,2**
Physical Environment					**0,18**	**0,20**	**0,32**	**0,35**	**0,14**	**0,15**
GHG emissions	1,00	0,33	0,28		0,30	0,29	0,40	0,45	0,38	0,34
Air quality index	1,00	1,50	1,60		0,32	0,32	0,29	0,27	0,31	0,33
Number of inhabitants affected by air pollution	1,00	3,00	3,36		0,38	0,39	0,31	0,28	0,31	0,33
Energy / Thermal comfort					**0,23**	**0,22**	**0,30**	**0,29**	**0,32**	**0,32**
Anthropogenic heat loss	1,00	1,80	1,90		0,58	0,58	0,43	0,41	0,37	0,35
Number of inhabitants with access to public transport	1,00	1,70	1,80		0,42	0,42	0,57	0,59	0,63	0,65
Land use / Urban Design					**0,37**	**0,35**	**0,17**	**0,16**	**0,21**	**0,20**
Local green areas	1,00	0,91	0,80		0,31	0,31	0,28	0,30	0,28	0,24
New inhabitants	1,00	3,00	3,60		0,19	0,17	0,25	0,22	0,28	0,30
Access to consumer services	1,00	1,15	1,20		0,21	0,23	0,31	0,27	0,32	0,30
Aesthetics	1,00	0,93	0,93		0,29	0,29	0,16	0,21	0,12	0,16
Economic viability					**0,22**	**0,23**	**0,21**	**0,20**	**0,33**	**0,33**
Impact on the economy	1,00	1,20	1,50		0,32	0,32	0,40	0,41	0,33	0,34
Cost of the intervention	1,00	1,50	2,00		0,36	0,37	0,32	0,33	0,32	0,32
Employment created	1,00	1,70	1,80		0,32	0,31	0,28	0,26	0,35	0,34

A.5 Scores estimate and weights for Gliwice

Gliwice	Planning Alternatives				Scenarios					
	Scores I	Scores II	Scores III		WI,1	WI,2	WII,1	WII,2	WIII,1	WIII,2
Physical Environment					**0,20**	**0,20**	**0,36**	**0,35**	**0,09**	**0,09**
GHG emissions	1,00	0,90	1,08		0,15	0,17	0,21	0,20	0,23	0,24
Air quality index	1,00	0,80	1,10		0,26	0,25	0,16	0,17	0,24	0,26
Number of inhabitants affected by air pollution	1,00	0,90	1,20		0,22	0,24	0,18	0,18	0,22	0,21
Infiltration	1,00	1,67	0,28		0,17	0,16	0,20	0,21	0,14	0,14
Potential flood risk	1,00	0,50	1,70		0,20	0,18	0,25	0,24	0,17	0,15
Energy / Thermal comfort					**0,14**	**0,13**	**0,27**	**0,29**	**0,29**	**0,31**
Percentage of energy from renewable energy sources	1,00	1,30	1,10		0,35	0,35	0,59	0,61	0,49	0,53
Number of inhabitants with access to public transport	1,00	0,50	1,50		0,65	0,65	0,41	0,39	0,51	0,47
Land use / Urban Design					**0,35**	**0,35**	**0,27**	**0,26**	**0,23**	**0,22**
Local green areas (area)	1,00	0,50	1,19		0,20	0,20	0,28	0,29	0,20	0,22
Reclamation of brownfields	1,00	1,00	2,00		0,21	0,20	0,25	0,25	0,28	0,27
Access to consumer services	1,00	0,50 €	1,30 €		0,18	0,19	0,18	0,18	0,30	0,31
Leisure infrastructures (exc. green areas)	1,00	0,50	1,00		0,18	0,18	0,15	0,14	0,14	0,13
Aesthetics	1,00	1,00	1,50		0,23	0,23	0,14	0,14	0,08	0,07
Economic viability					**0,31**	**0,32**	**0,10**	**0,10**	**0,39**	**0,38**
Impact on the economy	1,00	2,00	3,30		0,31	0,32	0,30	0,28	0,24	0,24
Cost of the intervention	1,00	0,34	1,34		0,22	0,14	0,20	0,20	0,26	0,26
Employment created	1,00	2,00	2,00		0,22	0,23	0,22	0,23	0,25	0,25
Qualified employment created	1,00	0,70	1,70		0,25	0,31	0,28	0,29	0,25	0,25