POCACITO

european post-carbon cities of tomorrow

DEFINITION OF STORYLINES FOR THE FRAMING OF URBAN SCENARIOS

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LIST OF ABBREVIATIONS

BAU	Buisiness as Usual
CCS	Carbon Capture and Storage
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GTAP	Global Trade Analysis Project
GVA	Gross Value Added
IPCC	Intergovernmental Panel for Climate Change
PPP	Purchasing Power Parity
RCPs	Representative Concentration Pathways
RE	Renewable Energy
SSPs	Socio economic Pathways
WP	Work Package

I EXECUTIVE SUMMARY

Foresight analysis, or the "systematic, participatory, future-intelligence-gathering and medium-to-long-term vision-building process aimed at enabling present-day decisions and mobilising joint actions" is the foundation of the POCACITO project. POCACITO intends constructing visions for post carbon futures of European case study cities in a participative process. Supporting this aim, the present document provides an outline of existing scenario exercises which serve as background references for the POCACITO background scenario and provides an outline of the narrative which shall be used for framing of the local visioning and scenario building exercise. Among existing scenario and foresight exercises, especially those providing ideas about a global vision on the background of economic, demographic and social aspects have been considered, in order to identify relevant drivers and pathways identified in the literature. The analysis takes into consideration the scenarios produced in the context of global environmental initiatives like the Millennium ecosystem assessment, and the Environmental outlook provided by OECD, the WBCSD Global Scenarios 2000 – 2050 and the new socio-economic pathways (SSPs) produced for the IPCC fifth assessment report published in 2014. A second focus of the analysis is directed to scenarios developed with a sector specific focus. Some scenarios focussing on specific issues of particular relevance for urban post carbon futures, like transport, water management, energy and economic development have been analysed.

Based on this analysis the members of the POCACITO consortium decided to choose one of the socio-economic pathways (SSPs) as a reference for outlining the POCACITO Background scenario.

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II THE ROLE OF GLOBAL SCENARIOS IN THE POCACITO BACK-CASTING EXERCISE

> "*A scenario is not a prediction of what the future will be. Rather it is a description of how the future might unfold. Scenarios explore the possible, not just the probable, and challenge users to think beyond conventional wisdom. They support informed action by providing insights into the scope of the possible*" (United Nations Environment Programme 2008).

Foresight analysis, or the "systematic, participatory, future-intelligence-gathering and medium-to-long-term vision-building process aimed at enabling present-day decisions and mobilising joint actions" (EFP 2001), is the foundation of the POCACITO project. Since cities often act as innovators in governance and technologies, developing foresight exercises and building scenarios is of crucial importance for strategic planning. Key actors at the city level can support planning transition processes by improving the decisions on long-term investments in infrastructures and policies, which ultimately change the urban shape, urban carbon performance and lifestyles of inhabitants. When properly designed and implemented, foresight activities improve the quality, impact and innovativeness of decision making.

Box 1: Scenario Building - Definition of Terms

Scenario

A plausible description of how the future may develop based on a coherent and internally consistent set of assumptions ("scenario logic") about key relationships and driving forces (e.g., rate of technology change, prices). Note that scenarios are neither predictions nor forecasts. *(Nakićenović et al. 2000).*

(Scenario) Family

Scenarios that have a similar demographic, societal, economic and technical-change storyline. The IPCC SRES report presents four scenario families: Al, A2, Bl and B2 which have been subsequently used by different modelling groups providing different outcomes for each of the storylines. *(Nakićenović et al. 2000).*

(Scenario) Storyline

A storyline contains the narrative description of a scenario (or a family of scenarios) outlining its characteristics and underlying logic, especially with regards to the key driving forces the scenario is built on and the dynamics of their evolution *(Nakićenović et al. 2000).*

Foresight activities within POCACITO do not aim to predict the future, but rather to create a platform to *think, debate, and shape* it with stakeholders at the city level. In doing so, scenarios support the learning process about the factors and trends which form future developments thereby providing insight about the long and short-term consequences of actions taken today. Unlike projections and deterministic modelling, scenarios and visions are based on *assumptions and views* of future developments, taking into account uncertainty, complexity and discontinuity. Since the goal of foresight activities is to actively shape the future, the project focuses on aspects that local stakeholders are able to influence (i.e. those addressed by urban policies). The present document aims at describing possible options for scenario building and background scenarios.

Describing a future that might possibly evolve from trajectories extrapolated from present drivers or developments, scenarios facilitate the identification of drivers of change and of possible implications of

current developments on the future (Raskin 2005) or can highlight consequences of surprising and uncertain developments and potential nonlinear future development (Alcamo, Vuuren, et al. 2005).

Scenarios represent a consistent set of assumptions about trends and forces driving future change and key relationships between these trends. They consist of a credible and coherent description of each of the alternative possible futures considered in the exercise. These assumptions are described in a qualitative, narrative manner in storylines. Recent approaches to scenario building integrate these qualitative approaches with quantitative considerations about the future, using variables provided by the storylines in quantitative modelling exercises which provide a structured and rigorous consideration of the inputs (see, for instance, Kram and Stehfest 2012; or Alcamo, Vuuren, et al. 2005). The use of predictive modelling broadens the scope of qualitative descriptions of scenario exercises, allowing the inclusion of processes which have not yet been considered in a quantitative manner and quantify implications of non-linear developments, surprising events etc. The use of consolidated scenario building strategies with respect to the definition of the narrative assures that the scenario building exercise responds to the scope of the policy process it is related to, and is understood by its end users.

II.I NORMATIVE VERSUS EXPLORATIVE SCENARIOS

Scenarios can be designed in two directions, either looking forward in order to explore future consequences of relevant trends or developments, or looking from an hypothetic future situation back onto trends and actions that potentially could have led to this situation. One fundamental difference between normative and explorative scenarios is determined by their purpose in a policy making process: as scenarios are a creative way of thinking systematically about the future, they are very useful tools for exploring possible future developments. Explorative scenarios allow for the reflection on possible developments of present trends into the future, taking into account eventually also surprising events (i.e. events that have a low probability of occurrence but a high impact) and include information different from those formulated in projections, for example about hypothetic future interactions between different elements of the system. Normative Scenarios produce “a picture of the world achievable (or avoidable) only through certain actions. The scenario itself becomes an argument for taking those actions”(Ogilvy, 1992, cited by Carter et al. 2001). Unlike explorative scenarios, normative scenarios start from a future vision and develop, subsequently, pathways and narratives how these visions or possible futures might be reached (Alcamo, Vuuren, et al. 2005). Both types of scenarios are based on storylines that are narratives which develop, in a qualitative manner, stepwise developments.

II.II BACK-CASTING SCENARIOS

Normative or back-casting scenarios, instead of exploring the development of existing trends (and surprising events) into the future, address a perceived societal problem, depicting a desired future state and explore the strategies for reaching these states. Among the different types of scenarios, back-casting scenarios are particularly interesting for a context of normative reflection on policies. This approach, which is part of the normative approach to scenario building, is based on the definition of concerns about desirable futures and the way these can be attained. “It is thus explicitly normative, involving working backwards from a particular desired future end-point to the present in order to determine the physical feasibility of that future and what policy measures would be required to reach that point.” (Robinson 1990, 822). This approach, formalised by Robinson (Robinson 1982; Robinson 1990) has been applied in various exercises connected to future energy and transport policies (Carlsson-Kanyama et al. 2008) and will be used during the POCACITO scenario workshops..

II.III FUNCTION OF SCENARIOS WITHIN POCACITO

Cities and their futures are interconnected with global futures and cannot be imagined without considering global developments. In describing scenarios for local urban futures, global developments need to be taken into account, as global trajectories describe the framework for local action and policies. Acknowledging this dependency between local futures and global trends, the back-casting exercise which will be undertaken in the POCACITO workshops in each of the case study cities will be articulated in a two-step approach: in a first step, a global scenario describing a possible global future has been developed by POCACITO scientists and described in the present document. This global future will represent the background for the local scenarios which will be developed in the second step in case study workshops, allowing for local stakeholders to design their vision for a post-carbon future on this scenario, which will represent the basis for the back-casting exercise and the local roadmap.

This two-step approach of scenario building provides a certain grade of consistency among the different local futures depicted, as basic assumptions about the future made in the different local scenario exercises are common across the different case studies.

II.IV METHODOLOGY

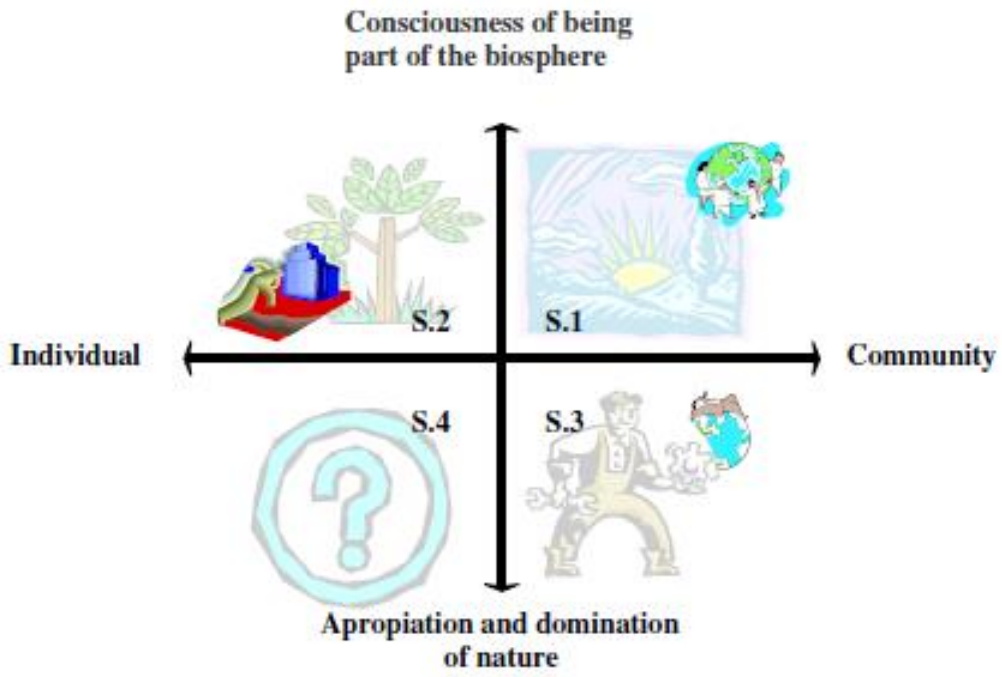
Whereas the local scenarios for the back-casting exercise will be developed in a participative process with local stakeholders in local workshops, the definition of the background storylines is made by POCACITO scientists in a desk exercise.

Basically, for designing the background storylines for urban future scenarios, two possible approaches are feasible: one consists in choosing tout court among the existing global scenario exercises, referring to global pictures described in these exercises.

For the first approach, a review of existing global (or European) scenarios is needed which provides the necessary elements for the choice among sets of scenarios identified.

The second approach consists of building scenarios ad-hoc, based on the identification of principal driving forces which are considered relevant for post-carbon futures, inspired by a description of trends and surprising elements identified in existing scenarios. The most feasible approach in this direction is based on a scenario axes approach, which identifies extreme developments in important driving forces which comprise the greatest range of uncertainty and/or variance of outcomes and combines these future developments into a set of storylines. The result of this scenario axes exercise will be four different archetypal scenarios if two main drivers are explored. Often the origin of the axes coincides with the Business as Usual (BAU) scenario (see Figure 1). They depict possible developments as the result of a combination of alternative assumptions on the future of these two main drivers. More complex sets of scenarios can be developed using a matrix approach which allows for the inclusion of a larger set of variables. Especially if more than two drivers are employed, internal consistency needs to be addressed in order to avoid the creation of illogic or contradictory combination of drivers.

Figure 1: Example for the application of scenario axes



Source: Bernal and Zografos, 2012

II.V ADVANTAGES/DISADVANTAGES OF DIFFERENT OPTIONS

The advantage of adopting a storyline defined for a global scenario is that local scenarios will potentially be able to refer to quantitative outputs from integrated modelling and assessment exercises with respect to climate scenarios etc., and rely on a solid and coherent set of assumptions and data. The disadvantage of using global scenarios as the starting point lies in the scarce detail provided by global outlooks compared to very specific local context, so some (or quite a lot) of interpretation and scenario interpretation for the "downscaling" of global scenarios to the local conditions might be needed. This applies both to climate and environmental as well as socio-economic developments. Caution is therefore required when building local scenarios based on global scenarios.

The advantage of the scenario axes option, where two key dimensions are combined with contrasting conditions and applied to the design of futures of each of the local contexts, is that it allows for the definition of a very specific POCACITO scenario framework, which is able to address the issue of transition of post-carbon scenarios in an easy to visualise manner using relatively few information on additional drivers of change. On the other hand, reducing the scenarios to two main drivers implies the risk of presenting a too simplified picture of the complexity of elements conditioning urban futures. The more complex scenario matrix approach, which allows for increasing the number of drivers of change to be considered, can accommodate more complexity, but comes with the price of reduced communicability and increased complexity for the construction of the scenarios, as, among others, internal consistency needs to be checked for each of the combination of states of the drivers considered. Further disadvantages of both approaches are connected to the additional work required for the construction of an internally consistent framework of storylines to be used by local experts. Especially the more complex approaches based on scenario matrixes will require POCACITO researchers to dedicate consistent resources into the building of scenario storylines.

It should be noted that, in principle, the global scenarios and the scenarios axes approaches are not entirely mutually exclusive. One can build the two axes scenarios in a way that is broadly consistent with the evolution of some main drivers of the global scenarios, basing the storylines on some of the assumptions made in the existing global scenarios. In doing so, consistency checks and credibility are strictly related to those of the global scenarios. This would, in principle, be a highly advisable course of action, but it is subject to a preliminary check of its feasibility that will be possible only when global scenarios have been analysed for their suitability for the purpose of POCACITO.

II.VI USE OF THE BACKGROUND SCENARIOS

Both options will lead to the definition of a reduced set of background storylines, which can then be translated, in each case study, into strategic back-casting scenarios for the transition process. Actually the decision of the POCACITO Consortium was to formulate only one background scenario in order to reduce complexity for the case study workshops. The strategic scenario will be combined with the visions formulated in a first step of the case study workshops, where participants will explore ideas and expectations on a post-carbon future for their city.

The remainder of the document is articulated as follows:

It consists of a short description of global scenario exercises by describing the drivers which are potentially relevant for the local POCACITO scenarios and should thus be described in the background storylines. Based on these presentations and the needs articulated by the respective project partners conducting the case study, it will identify relevant sectors and drivers for the design of POCACITO background storylines, and sketch these storylines for the use in the local scenario workshops.

III EXISTING SCENARIO EXERCISES – A REVIEW OF LITERATURE

III.I SHORT DESCRIPTION OF STORYLINES AND ISSUES ADDRESSED

Scenarios have been developed for a great number of decision-making purposes. In order to locate the POCACITO activity on Scenarios in relation to these existing reflection and foresight analysis, and to identify relevant issues and trends to be taken into consideration, a short overview on existing and relevant scenario exercises was produced. Relevant publications were screened and, for those deemed potentially interesting for the development of POCACITO urban post carbon scenarios, short descriptions of the main characteristics were made. The members of the POCACITO consortium screened existing databases for scenarios (for instance EEA 2009) and provided descriptions of those scenarios they were familiar with. Criteria for the choice of scenarios to be included into this review exercise were mainly based on their ability of describing global developments relevant for urban post carbon strategies in a holistic manner, so that participants in case study workshops could use them to identify the future world and locate their own local context in relation to the changes described.

The initial analysis covers existing scenario families resulting of the following key outlook exercises: Scenarios considered have been grouped in two main areas, one of those providing comprehensive visions of future developments, and a second group exploring future trends related to aspects which are of specific interest for the visioning and scenario building exercise of POCACITO. A choice of sector or issue related scenarios has been included in this review with the aim of providing more specific input to the local scenario building in relation to possible future development in relevant policy sectors or related to important environmental issues which might potentially gain relevance during the scenario building process in the case study cities.

COMPREHENSIVE SCENARIOS DESCRIBING GLOBAL DEVELOPMENTS:

- Millennium Ecosystem Assessment
- WBCSD Global Scenarios 2000 - 2050
- UNEP Global Environment Outlook 4: Environment for Development
- OECD Environmental Outlook 2050
- Socio-economic pathways for climate change research (SSP)

SECTOR ORIENTED SCENARIOS AND FORESIGHT EXERCISES

Sector or partial scenario exercises have been created aiming at reflection on specific policy design issues, mostly related to sector related issues.

- Climate and Energy Policies

- Social and Economic challenges
- Water Policies
- Transport Policies:
- Urban Policies

III.II GLOBAL SCENARIOS FOCUSSING ON ENVIRONMENTAL ISSUES

Albeit driven by concerns on specific policy issues, the scenario exercises presented in the context of the Millennium assessment (2005) and the OECD environmental outlook (OECD 2012), both dating from the middle of the past decade, have been included among the comprehensive scenario exercises, because driving forces and sectors described are not limited to the environment or ecosystems, but include economic performance and social transformation and focus on the interactions between environment, economic development and governance as well. They provide thus examples for global and comprehensive scenarios, which are, although having been formulated almost 10 years ago, still of some relevance for more recent scenario exercises.

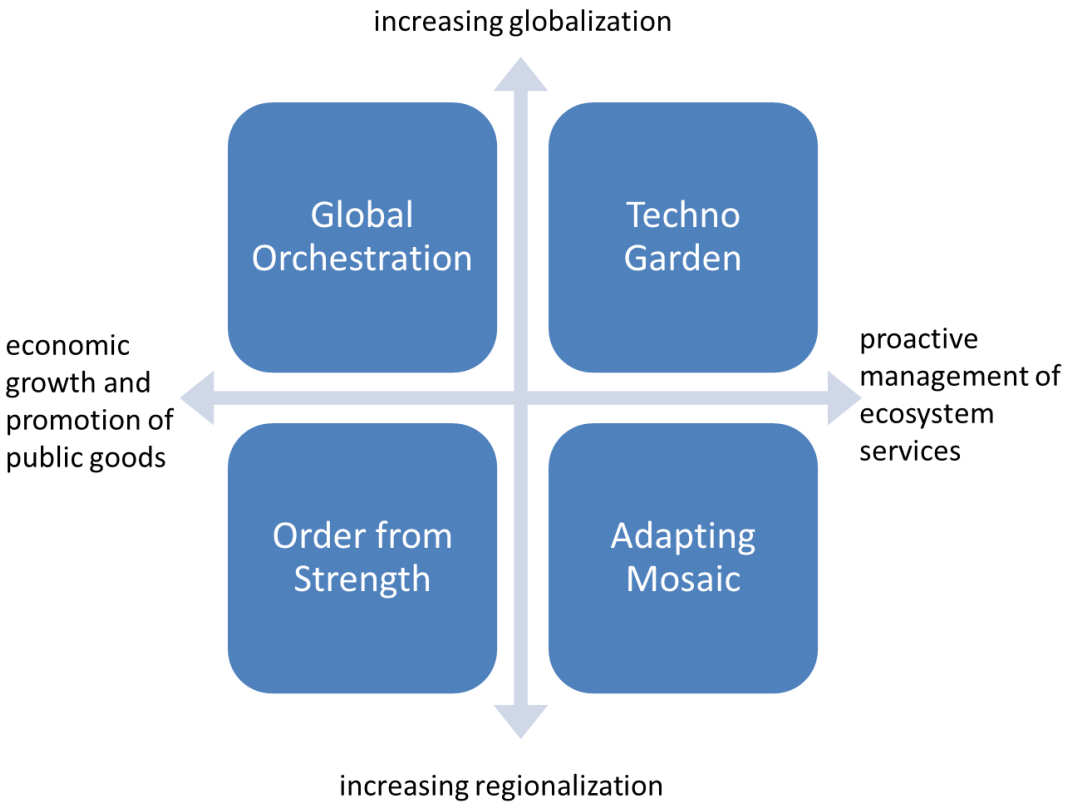
III.II.1 MILLENNIUM ECOSYSTEM ASSESSMENT

In the context of the Millennium Ecosystem Assessments (Millennium Ecosystem Assessment 2005; Alcamo, Alder, et al. 2005), scenarios have been used in order to explore implications which future social and economic developments might have on ecosystem services. The exercise is based on four different storylines, describing four different possible global futures on both a narrative, qualitative level and a model based quantitative level. In a second step, as results from modelling exercises, implication of these changes have been quantified in terms of changes in ecosystems services. While the qualitative storylines presented provide a comprehensive set of assumptions on future developments of drivers and interactions, the modelling exercises are limited to some interactions between drivers and environmental outcomes that can be represented in a numerical environment. The four storylines are delimited by different assumptions on main lines of socio-economic policies and, connected with these, strategies for the management of ecosystem services and sustainability. They follow lines defined by a “set of archetypal visions of the future” underlying different scenario exercises developed so far, which depict four main directions of development: gradual evolvements of actually dominating driving forces; these driving forces are:

- Increasing fragmentation and diverging developments versus more inclusive and globalised developments
- Strongly growth oriented policies promoting public goods; versus futures based on innovative forms of proactive management of natural resources (Bennett and Cork 2005).

The storylines used within the Millennium Assessments (MA) exercise follow these lines, providing for each of them more explicit descriptions of strategies for sustainability policies and ecosystem management strategies.

Figure 2: Scenario axes for the Millennium Assessment Scenarios



- The gradual evolvement of actually dominating driving forces is represented, within the MA, by the **Global Orchestration** (GO) scenario, which assumes sustainability to be achieved mainly using global economic and social policy strategies and goals like economic liberalisation, poverty reduction, investment in public goods as for example infrastructure and education. The conservation of ecosystem services is faced through a reactive approach, assuming that only the improvement of economic well-being will provide the demand for a well-functioning environment and allow for the resolution of environmental problems, such as climate change and loss of biodiversity and deliver, at the same time, the means to achieve these goals.

- The increasing fragmentation of economic and social development represents the underlying theme for the **Order from Strength** (OS) scenario, which assumes an increasingly regionalised and fragmented world, where security and protection are a major concern for more developed countries in face of great or increasing inequalities. Like in the global orchestration scenario, the approach to ecosystem conservation is reactive, it attempts to keep poverty, conflict, and trends of deterioration of ecosystems outside their borders.

- The **Techno Garden** (TG) scenario represents a strongly interconnected world which relies on a highly technologic and managed proactive approach towards ecosystems based mainly on sound technology and engineering for the management of environment issues.

- The **Adapting Mosaic** (AM) scenario represents a second version of a fragmentation future, where a strongly proactive approach for the conservation of ecosystem services stems from regional and local grassroots' like initiatives which are based on common property institutions organised at ecosystem level. Investments in human and social resources focus on understanding and

management of these ecosystems, and international management is based on networking between local units.

Each of these scenarios is described in three 15/20 year time steps from 2000 to 2050. A further chapter describes the challenges for the period from 2050 to 2100.

The description of the storylines provides an outline for each of the period describing the main characteristics of economic, social and environmental policies. Furthermore, outcomes of each of the scenarios are described briefly for relevant sectors such as fisheries, climate change, eutrophication, invasive species, coastal wetlands and urbanisation, and for single local environmental problems, like the Gulf of Mexico hypoxia.

In addition to the scenarios based on these storylines, sector oriented model based quantifications have been used for the description of direct changes (concentration of greenhouse gases, changing climate, air pollution, acidification of oceans, sea level rise, land use and land cover changes, concentration of fertilisers and nitrogen loads in freshwater and marine systems) and indirect drivers of change for ecosystem services (population, economic development, technological change, social, cultural and political change, energy use). Based on the modelling of these direct and indirect drivers, outcomes for ecosystems services (distinguishing between provisioning, regulating, supporting and cultural ecosystem services) are provided.

Time horizon: The time horizon used for the scenarios is 2050. The base year for the scenarios is 2000.

Driving forces: globalization, forms of ecosystem management

Sectors covered: The scenarios provide quantifications for population growth, economic activities, technology change, energy use, emissions of air pollutants, GHG, climate change, land use, resource consumption; qualitative assumptions are made for socio-political features, culture, religion and introduction of species.

Geographical focus: The scenarios and the assessment have a global focus, but regional studies are also provided.

Scale: The data presented distinguishes between industrialised and less industrialised nations, but as far as quantifications of models are concerned, national data is available.

Relevance for urban Post Carbon Futures:

Published in 2005, these storylines have informed several generations of subsequent scenarios, and are, with respect to the main driving forces, similar to those formulated in the Special Report on Emission Scenarios SRES which were the first set of scenarios for the IPCC (see Nakićenović et al. 2000). Most of the quantifications provided (population growth, trends in economic activities and technology change, energy use, emissions of air pollutants, GHG, climate change, land use, resource consumption) are in fact crucial issues both for scenarios depicting outcomes of climate policies and for urban post carbon futures.

III.II.2WBCSD GLOBAL SCENARIOS 2000 - 2050

The World Business Council for Sustainable Development (WBCSD) developed three scenarios in order to address the following questions (WBCSD 1997):

- "What are the critical thresholds in soil, air, climate, water, and biodiversity, and how do we recognize these limits? How resilient is the global ecosystem?
- What human social systems can best respond to the challenge of sustainable development"

The three scenarios differ regarding to the role of markets and governments or of economic versus environmental priorities.

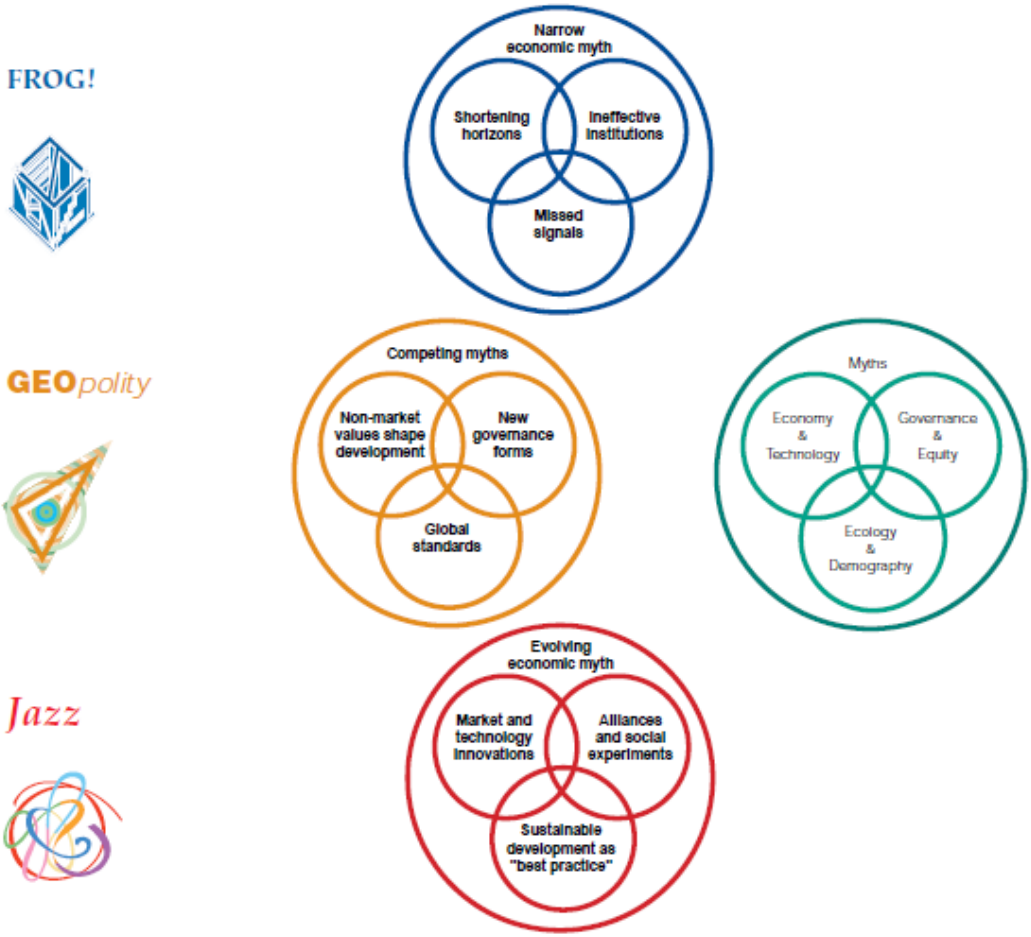
- **First Raise Our Growth (FROG!)**: Sustainable development is not top priority in the FROG scenario but economic growth. In this scenario some countries leapfrog from an underdeveloped status to benchmarker in particular areas of technology. People in western nations respond in uneven ways—sometimes by offering help in improving the environment. Sustainable development is not top priority in the FROG scenario but economic growth, environmental health however in many areas improves significantly. Environmental improvements, such as in local air quality, solid waste management, and environmental education would lead to a perception that the environment is in much better shape than it was in the late 1990s. On a global level, according to the FROG there is a less clear picture. Due to economic growth and the increase in population, greenhouse gases are rising, but people are not sufficiently aware of the problem... But, by 2050 it becomes clear that the worst predictions about global warming are actually nearer to reality than the more optimistic ones. In FROG, the habitual reliance on technology has not been sufficient to solve longer-term problems of either environmental or social health. Globalisation and liberalisation of markets along with the pressures of rapid urbanisation have raised a high degree of social inequity and unrest up to a level that threatens the existence of both human and environmental ecosystems (WBCSD 1997).

- GEOpolity: In the Geopolity scenario governments act as focal points of civil society. Governments take the lead in shifting the structure of the economy towards sustainable development instead of markets but they still cooperate with these. New institutions such as the Global Ecosystem Organisation (GEO) are created GEOpolity considers the emerging evidence or signals—that an environmental and social crisis may appear. The growth first paradigm as in FROG, where is seen increasingly dangerous.- The role of multinational institutions is growing as governments have lost credibility to solve problems. Business has no solutions to the global problems and is even seen as barrier to problems. Its actions are not coordinated on a global level, and it seems to lack the will even to address the problems. People begin to demand new social institutions. Some of these involve the strengthening of governance — for example regional governance structures as "sustainable cities", while others are politically innovative. The perceived need responses leads to a new global consensus that welcomes technocratic solutions, sanctions, and more direct that the market has no inherent incentives to protect the commons, social welfare, or any other non-economic values. The absence of leadership from business and government to solve problems, promotes new global institutions—such as the above mentioned Global Ecosystem Organisation (GEO). The GEO has broad powers to design and enforce global standards and measures to protect the environment and preserve society—even if doing so requires economic sacrifice (WBCSD 1997).

- Jazz: In the world of the Jazz scenario, diverse players join in ad hoc alliances to solve social and environmental problems in the most pragmatic possible way. Jazz represent a world of social and technological innovations, experimentation, rapid adaptation, much voluntary interconnectedness, and a powerful and ever-changing global market (WBCSD 1997). A major enabling factor for quick learning and subsequent innovation in Jazz is high transparency for consumers, representing a high availability of information about products and their components company financial, environmental, and social data or government decision-making processes..

Many players are involved, in part because the way information technology lowers barriers to entry allows new actors to step onto the economic stage. And that stage itself is characterised by a global free market, sound legal systems, and a respect for property rights. To the extent that government is involved, it is most active at the local level, with ad hoc global institutions arising to solve particular problems. Agreements are reached through mediation in a world in which transparency is required, but particular "green" behaviours are not, even though such behaviours are rewarded. Achievement of the new environmental and social standards occurs The public is made aware of transgressions and quickly acts against companies or countries that violate standards. Companies have an interest in seeing that disputes do not escalate and indirectly harm them. They monitor relationships with customers and suppliers closely and drop risky partners quickly. In this highly competitive and interconnected world, businesses see strategic economic advantages in being perceived as environmentally and socially responsible, and many become pro-active leaders in responding to social and environmental challenges. Jazz is a world in which NGOs, governments, concerned consumers, and businesses act as partners—or fail.

Figure 3: Sustainability Dimension in the WBCD Scenarios



Source: (WBCSD 1997)

Driving forces: Globalisation, Urbanisation, social and technological innovations, economic growth

Sectors covered: entire economy

Time horizon: 2050.

Geographic scope: global

Scale: global

Relevance for urban post Carbon Scenarios:

The exercise represents an interesting view on possible forms of relationships between economic drivers and governance for environmental quality and achievement of goals of de-carbonization.

III.II.3 UNEP Global Environment Outlook 4: Environment for Development

The third and fourth Global Environmental Outlook (GEO 3 and GEO 4), published by United Nations Environment Programme (UNEP, 2002, 2007) are also based on a set of four qualitative scenario storylines, similar to the archetypical set of scenarios presented before and reinterpreted also by the Millennium ecosystem assessment (see par. III.II.1):

Descriptions of the storylines are mainly qualitative, pointing at the main policy lines underlining socio-economic development and environmental management. The storylines are underpinned by different quantitative assumptions on demographics, economic and social development and provide quantifications for economic, social and climate change impacts for each of the scenarios and differentiated for each of the global regions, using in part outputs from integrated models like IMAGE (Raskin 2005). These same scenarios have been used both in GEO 3 and in GEO4.

- **Markets first**, a scenario of global convergence based on market driven developments, dominated by the private sector which receives government support for maximum economic growth. Economic growth is seen as to provide the means needed for improving the environment and human wellbeing, focussing on technological fixes for environmental challenges. The scenario corresponds to the Global Orchestration (GO) scenario used subsequently in the Millennium Ecosystem Assessment.

- **Policy first**, a scenario assuming governments to undertake strong initiatives and relevant actions for improving social and environmental conditions, albeit promoting sustainable development, but in case of conflicting goals, economic and social concerns tend to prevail over environmental aims. The importance attributed to policy actions for achieving sustainability goals makes this scenario similar to the Techno Garden (TG) scenario in the Millennium Ecosystem Assessment.

- **Security first**, a scenario where government activities aim at protection against the socio-economic and environmental consequences of inequalities and conflicts resulting from a strongly segmented pattern of economic development, human wellbeing is being improved or at least maintained mainly fo the rich and powerful. The scenario points at the similar trends as the Order from Strength (OS) scenario used in the Millennium Ecosystem Assessment.

- **Sustainability first**, a scenario where future developments are determined by new more equitable values and institutions. The scenario is similar to the Adapting Mosaic (AM) scenario used in the MA, although the element of prevailing local solution, which represents a central element of the "Adaptive Mosaic" storyline, is not addressed in this case.

Sectors covered: the storyline considers Demography, Economic and human development, science and technology, governance culture and environment, as drivers, economic sectors considered comprise, inter alia, fisheries.

Time horizon: for GEO3 the time horizon is 2032 and the base year 2002, it has been extended, for GEO4, to 2050.

Geographic focus: global scenarios with specific focuses on regional or continental issues.

Scale: Environmental outcomes are considered at global scale, but single issues are considered, where relevant, at regional scales.

Relevance for urban post-carbon scenarios:

Similar to the millennium assessment scenarios, these scenarios address interconnectedness between societal and environmental changes, and similar drivers and storylines are used.

III.II.4 OECD ENVIRONMENTAL OUTLOOK 2050

The OECD environmental Outlook 2050 (OECD 2012) does not apply a scenario approach in a straight sense to the outline future visions of a global state of the environment, but provides a mainly quantitative foresight exercise which assesses economic and environmental impacts expected from policy options for each of the environmental issues considered (Biodiversity, Climate change, Water, Health). The assessments are based on an integrated modelling exercise coupling socio-economic and environmental models. The results are assessed against a reference baseline scenario describing the environmental outcomes of present demographic and economic trends (policy approaches to environmental management remain unvaried). The assessments are made in two time steps, for 2030 and 2050.

Driving forces: OECD the environmental outlook explicitly aims at the formulation of an outlook, and is thus based on projections rather than drivers which could influence possible alternative futures. Projections are provided for demography and economic activities, climate change, whereas among areas impacted, further to the environment and human health, water and biodiversity are considered.

Sectors covered: Economic and demographic development, environmental degradation.

Time horizon: 2030 and 2050.

Geographic scope: global, with focus on specific geographic regions for single policy simulations

Scale: the aggregation most frequently used throughout the outlook refers to three groups of countries based on economic criteria: OECD; BRICS; rest of the world; nevertheless, the modelling tools employed allow for the use of national specific data.

Relevance for urban Post Carbon Futures:

Both socio-economic drivers considered and environmental outcomes described can provide a useful background for POCACITO scenarios.

III.II.5 SHARED SOCIOECONOMIC PATHWAYS

The Shared Socioeconomic Pathways[1] (SSPs) – a set of qualitative and quantitative narratives that describe future socioeconomic conditions – were recently developed[2] by the scientific community to

[1] See Box 2 for an important distinction between the terms scenario and pathway according to the new scenario framework.

enable the exploration of factors that are important for the assessment of future greenhouse gases emissions and mitigation and adaptation activities (Kriegler et al. 2012; van Vuuren et al. 2012). The SSPs comprise *one component* of the new scenario framework for climate change research, building on the Special Report on Emission Scenarios (SRES) developed for the Intergovernmental Panel on Climate Change (IPCC) (Ebi et al. 2013). The new scenario framework will substitute the SRES as the main reference for scenario building exercises within the climate research community.

The main components of the new scenarios are 1) a set of concentration pathways[3], or the Representative Concentration Pathways (RCPs), 2) the Shared Socioeconomic Pathways (SSPs), and 3) the Shared Climate Policy Assumptions (SPAs)[4] [5]. The SSPs are of particularly interest to the POCACITO project because the set of pathways will serve as the socioeconomic reference for future climate projections and research. The design of the SSPs (see Section 0) also allows for significant flexibility in terms of analysis, which will help the stakeholders of POCACITO identify climate-related challenges consistent with the socioeconomic aspects of post-carbon visions (and vice versa). The following paragraphs, briefly describe the SSPs in relation to the POCACITO project activities – the reader should consult other sources for an in-depth analysis of the components of the new scenario framework (for example,Kriegler et al. 2012; Moss et al. 2010; B. O'Neill et al. 2012).

III.II.5.1.1.1 Purpose

The set of SSPs aims to facilitate the comparability of research across different disciplines by providing common assumptions about alternative future socioeconomic developments (at the global, regional and national level) in terms of population growth, governance efficiency, inequality (intra and inter-generational), institutional factors, technology change and environmental conditions (van Vuuren et al. 2013). SSPs can serve as "boundary conditions" (van Vuuren et al. 2013, p. 378) for the design of local post-carbon visions and scenarios, which aligns with the scenario-building approach taken by POCACITO. The socioeconomic pathways are translated into storylines based on worlds with various challenges to mitigation and adaption (Figure 4). The axes in Figure 4 correspond to the intensity of climate policies that are necessary in the future either to prevent a certain level of climate change (mitigation, vertical axis), and/or to cope with a certain level of climate change (adaptation, horizontal axis).

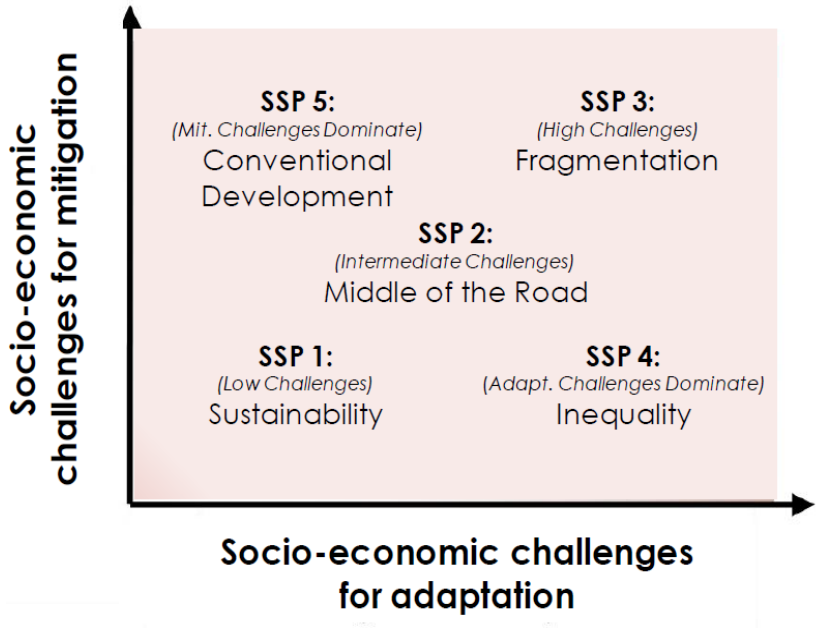
[2] The process began in 2006 (van Vuuren et al. 2014)

[3] Also referred to as "radiative forcing". Van Vuuren et al. (2014, 378) note that "forcing refers to the global average forcing on the basis of greenhouse gases and air pollutants. At the local scale, forcing (and therefore climate change) can be very different due to spatial patterns of land-use change and air pollutant concentrations."

[4] Projected climate change, and its uncertainty, is a fourth component that can be added the scenario axis van Vuuren et al. 2014

[5] Although many research studies will formulate their own policy assumptions (as in the case of POCACITO), a small number of shared climate policy assumptions have been formulated to improve the comparability among different models and analyses (Kriegler, Riahi, Petermann, et al. 2014; van Vuuren et al. 2014).

Figure 4: Five SSPs for which narratives have been developed



Source: O'Neill et al. 2012

METHODOLOGY

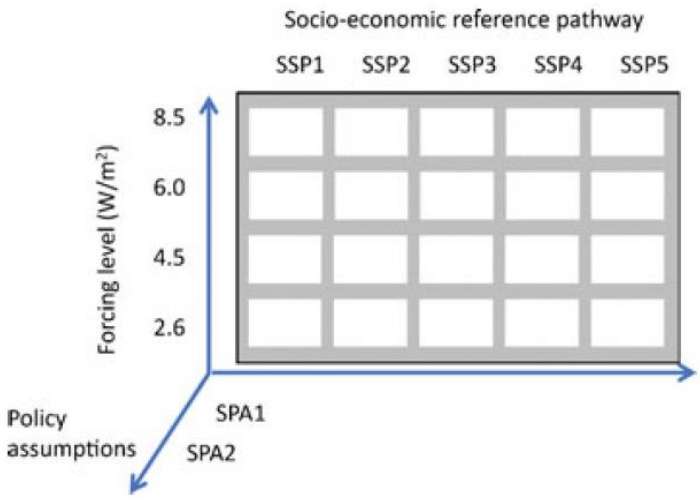
The new scenarios were developed using a much different approach than the SRES in order to facilitate the modelling of a broader range of response options to climate change related challenges, including both mitigation and adaptation. The approach of the SRES followed a "forward-looking logic" (Ebi et al. 2013). For instance, driving forces were first described. Then, the resulting emissions and atmospheric concentrations were modeled and finally, the magnitude of climate change was projected using climate models. The new scenarios, in contrast, were developed by first agreeing on several atmospheric concentration pathways (the Representative Concentration Pathways, RCPs) and then developing the climate change projections and socioeconomic pathways that are consistent with the RCPs (Ebi et al. 2013). This can be characterised by a matrix architecture (Figure 5) – scenarios describe the overlapping space between the components (i.e., the cells in the matrix). Although the new approach leads to a more complex framework that is potentially difficult to communicate, it attempts to provide a more "comprehensive description of the scenario space for future climate policy" (van Vuuren et al. 2013, p. 384).

Two crucial assumptions of the new scenario framework are that the SSPs occur *without any new climate mitigation and adaptation policy interventions*[6] and that basic assumptions and drivers are *not influenced by future climate change* (B. C. O'Neill et al. 2013; van Vuuren et al. 2013) – i.e., they should be used as "reference pathways" combined with different climate policy assumptions to achieve different concentration outcomes. The separation of the SSPs from climate policies and impacts allows for great

[6] Kriegler et al. (2014) note that the primary distinction between climate policies that are included in the SSPs, such as energy policies, and those that are not included (even though many times closely related) is the intent of the policy ((Kriegler, Edmonds, Hallegatte, Ebi, Kram, Riahi, Winkler, and van Vuuren 2014; van Vuuren et al. 2014); van Vuuren et al. 2013)

flexibility and analytical use of the pathways. Because of the inverse relationship between concentration levels and climate mitigation, lower future concentrations imply greater mitigation across all SSPs, and thus, the importance of the policy assumptions (van Vuuren et al. 2013). Furthermore, it is important to keep in mind that under this framework, various socioeconomic development pathways can lead to analogous levels of radiative forcing (van Vuuren et al. 2013).

Figure 5: The matrix architecture of the new scenario framework[7]



Source: van Vuuren et al. 2013

In the context of a comparison of different scenarios, a matrix architecture can provide a very useful framework to analyse the costs and benefits of climate policy - Figure 6 illustrates an analysis of adaptation and mitigation policies using the scenario matrix (van Vuuren et al. 2014). For the purposes of the POCACITO project, different global and national scenarios could roughly indicate the costs of local climate adaptation and mitigation policies. Nevertheless, downscaling at the city level will still be necessary.

[7] Van Vuuren et al. (2014) note that not every cell on the scenario matrix will be populated since some SSPs may be inconsistent with radiative forcing levels and policy assumptions.

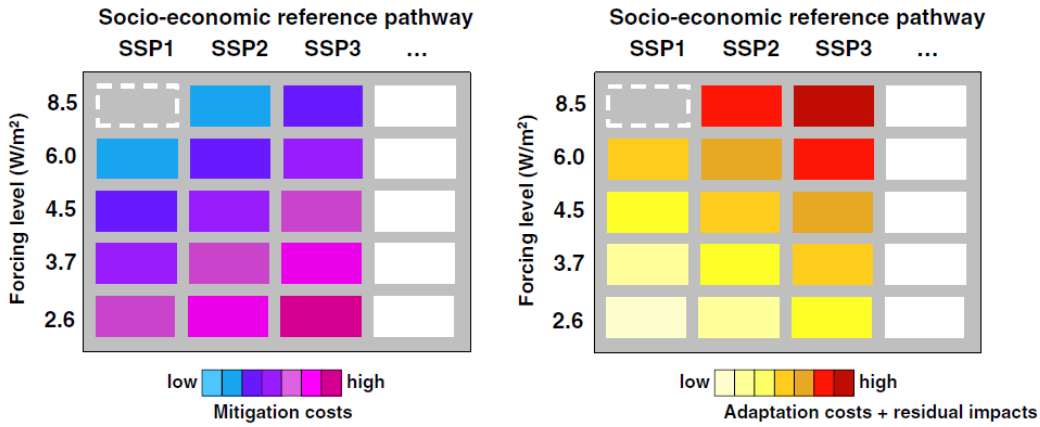
Box 2: Terminology: scenarios and pathways

"Scenario" and "pathway" – what's the difference?

Under the new scenario framework, the term scenario describes "a plausible, comprehensive, integrated and consistent description of how the future might unfold ... while refraining from a concrete statement on probability" (van Vuuren et al. 2012, 377; Nakićenović et al. 2000). Each cell in the matrix architecture (Figure 6) indicates a different scenario – i.e., the "integration of socio-economic, climate change, and climate change policy assumptions" (van Vuuren et al. 2012, 377).

Pathways (e.g., the RCPs and SSPs), on the other hand, refer to a "specific component of the future" (van Vuuren et al. 2012, 377) – for the SSPs, this refers to socioeconomic circumstances. Pathways must be combined to form comprehensive scenarios – e.g., the various combinations of a row (RCP) and column (SSP) in the matrix architecture that form different scenarios.

Figure 6: The matrix architecture as a heuristic tool



III.II.5.1.1.2 Narrative Description

The five SSP storylines are described in Box 3. The time horizon of the SSPs is 2100; they are described at the global level, which can be translated to national and urban circumstances. Each of the storylines contains indications of urbanisation trends (controlled urbanisation, urban sprawl, growth of informal settlements), and environmental quality in urban areas (different approaches to technology development, air pollution control, energy saving, etc.), which represent potential cornerstones for post-carbon developments.

Box 3: The SSP Storylines

SSP1 (SUSTAINABILITY) describes a world that aims at pursuing a sustainable development path, to achieving development goals while reducing resource intensity and fossil fuel dependency. environmentally awareness is at a high level and technology is developing fast, with strong economic growth, both in high and in low-income countries.

SSP2 (MIDDLE OF THE ROAD). This "business-as-usual" world sees the trends typical of recent decades continuing, with some progress toward achieving development goals. Dependency on fossil fuels is slowing decreasing. Development of low-income countries proceeds unevenly.

SSP3 (FRAGMENTATION). A world that is separated into regions characterized by extreme poverty, pockets of moderate wealth, and a large number of countries struggling to maintain living standards for a rapidly growing population.

SSP4 (INEQUALITY). A highly unequal world, in which a relatively small, rich global elite is responsible for most of the greenhouse gas emissions, while a larger, poor group that is vulnerable to the impact of climate changes, contributes little to the harmful emissions. Mitigation efforts are low and adaptation is difficult due to ineffective institutions and the low income of the large poor population.

SSP5 (CONVENTIONAL DEVELOPMENT). A world where conventional development is oriented towards economic growth as the solution to social and economic problems. Rapid conventional development leads to an energy system dominated by fossil fuels, resulting in high greenhouse gas emissions and challenges to mitigation.

Source: Storylines taken directly from IIASA 2014

As in the case of the Millennium Ecosystem assessment, global economic relations between developing and developed countries are a central part of the SSP storylines. For instance, **SSP1** depicts a more equilibrated development between developing and developed countries, where less developed countries are provided access to education, health and economic resources and well managed urbanisation processes. **SSP2** represents a continuation of present developments with a slow convergence of economic development between developing and developed countries and rates of success for urban policies addressing, for instance air quality. By contrast, **SSP3** represents a world with strongly unbalanced global developments, with less developed countries lagging behind. **SSP4** is based on the assumption that inequalities increase across and within all national contexts, with inequalities inducing high urbanisation rates. Finally, **SSP5** is based on conventional, growth-oriented development in developing and developed countries based on fossil fuels, very high urbanisation and migration rates, with a consequently high rate of urban sprawl (B. O'Neill et al. 2012).

III.II.5.1.1.3 Quantification

Since the narrative storylines can be interpreted in different ways, several research teams (Table 1) quantified the five SSPs in order to enhance the consistency and comparability of analyses[8]. The quantification of the SSPs is a collaborative effort between climate modellers (CM), and the integrated assessment (IAM), and the impacts, adaptation, and vulnerability (IAV) communities (IIASA 2014). The current database, which includes projections for population and economic development, can be accessed by visiting the IIASA database online:

Data are available for the following elements[9]:

- population by age, sex, and education
- urbanisation (percentage)

[8] However, van Vuuren et al. 2013 note that there are several trade-offs between providing a more narrowly defined framework and allowing for flexibility that allows for uncertainty and a wider variety of approaches and research designs.

[9] Please refer to the Supplementary note for the SSP data sets for a detailed description of the population, urbanisation, and GDP projections: https://secure.iiasa.ac.at/web-apps/ene/SspDb/static/download/ssp_suplementary%20text.pdf

- economic development (GDP)

The SSP database offers several options to download and visualise the data for the respective storylines.

The three different GDP projections differ in terms of employed methodology and outcomes – all three should be used to test the sensitivity of results (IIASA: Supplementary note for the SSP data sets). The main assumptions for the quantification of the SSP elements per storyline can be found in Source: (IIASA), Supplementary note for the SSP data sets: https://secure.iiasa.ac.at/web-apps/ene/SspDb/static/download/ssp_suplementary%20text.pdf

Table 2 and Table 3.

Table 1: List of SSP element projections by affiliated institute

POPULATION	URBANISATION	GDP
International Institute for Applied Systems Analysis (IIASA)	National Center for Atmospheric Research (NCAR)	Organisation for Economic Co-operation and Development(OECD) the International Institute for Applied Systems Analysis (IIASA) Potsdam Institute for Climate Impact Research (PIK)

Source: (IIASA), Supplementary note for the SSP data sets: https://secure.iiasa.ac.at/web-apps/ene/SspDb/static/download/ssp_suplementary%20text.pdf

Table 2: Main assumptions for the SSP population projections

	SSP 1			SSP 2			SSP 3			SSP 4			SSP 5		
							Country Groupings								
SSP Element	*HiFert*	*LoFert*	*Rich-OECD*	*HiFert*	*LoFert*	*Rich-OECD*	*HiFert*	*LoFert*	*Rich-OECD*	*HiFert*	*LoFert*	*Rich-OECD*	*HiFert*	*LoFert*	*Rich-OECD*
Demographics															
Population															
Fertility	Low	Low	Med	Med	Med	Med	High	High	Low	High	Low	Low	Low	Low	High
Mortality	Low	Low	Low	Med	Med	Med	High	High	High	High	Med	Med	Low	Low	Low
Migration	Med	Med	Med	Med	Med	Med	Low	Low	Low	Med	Med	Med	High	High	High
Education	High (FT)	High (FT)	High (FT)	Med (GET)	Med (GET)	Med (GET)	Low (CER)	Low (CER)	Low (CER)	V.Low (CEN)	Low (CER)	Med (GET)	High (FT)	High (FT)	High (FT)

Source: (IIASA), Supplementary note for the SSP data sets: https://secure.iiasa.ac.at/web-apps/ene/SspDb/static/download/ssp_suplementary%20text.pdf

Table 3: Main assumptions for the SSP urbanisation projections

	SSP 1			SSP 2			SSP 3			SSP 4			SSP 5		
	Country groupings for high, middle, and low income														
SSP Element	*High*	*Middle*	*Low*	*High*	*Middle*	*Low*	*High*	*Middle*	*Low*	*High*	*Middle*	*Low*	*High*	*Middle*	*Low*
Urbanization	Fast	Fast	Fast	Central	Central	Central	Slow	Slow	Slow	Central	Fast	Fast	Fast	Fast	Fast

Source: (IIASA), Supplementary note for the SSP data sets: https://secure.iiasa.ac.at/web-apps/ene/SspDb/static/download/ssp_suplementary%20text.pdf

Sectors covered: various

Time horizon: The time horizon used for the scenarios is 2100

Driving forces: population by age, sex, and education, urbanisation (percentage), economic development (GDP)

Geographical focus: The storylines are described at the global level, which can be translated to national and urban circumstances.

Scale: Global, national, and urban

III.IIISECTORAL OUTLOOKS:

The following scenario and foresight exercises have been taken into consideration as they shed light on particular issues connected to the design of urban post carbon futures: they address scenarios for economic policies, climate and energy trends, transport, water management, and urban policies.

III.III.1 CLIMATE AND ENERGY POLICIES

AMPERE

The AMPERE research project assessed climate mitigation pathways and estimates for the Robustness of Mitigation Cost Estimates, aiming at providing support and input for possible policy strategies toward medium- and long-term climate targets at the global and European levels.

The scenario study produced by the research project compares GHG emission scenarios simulated by AMPERE models (Kriegler, Riahi, Bauer, et al. 2014 Figure 1). The three scenarios produced by the project are organized according to the "policy intensity" of the pathways: from a "no policy" scenario, and a scenario based on the extrapolation of current trends to a scenario based on assumptions on strong global action. "No policy" is based on increasing emissions trends in a world without climate policy; "Extrapolation of current policies" indicates possible emission outcomes assuming that current emission reduction targets for 2020 are maintained through the century; and "Strong global action" is based on possible emission pathways assuming immediate global action to reduce emissions in order to limit warming to 2°C above pre-industrial levels. Moreover, the study compares delayed and immediate action scenarios for limiting warming to 2°C. (Kriegler, Riahi, Bauer, et al. 2014 Table 3).

At an EU level, the study assessed the alternative decarbonisation scenarios including the basic/optimal decarbonisation scenario for the EU in line with the Energy Roadmap 2050 and a series of decarbonisation scenarios under technological limitations (e.g. nuclear power phasing out, non-availability of CCS technologies, limited transport electrification) and delayed climate policy until 2030 (Capros et al. 2014 Tables 1,2). **The EU27 reference scenario** assumes the current GHG emission reduction and renewable (RE) targets up to 2020. In 2020-2030 the reference scenario assumes a linear annual reduction of the ETS cap (-1.74% per year), no additional policies for efficiency and RES, and limited electrification of transport. **In the EU basic decarbonisation scenario with all options available**, the cumulative carbon budget is imposed on top of the climate policies and measures that were implemented in the reference case until 2020. **In the decarbonisation scenario with high energy efficiency gains and high RES penetration**, all decarbonisation options are available (like in the AM5S2 scenario), but emphasis is given to energy efficiency gains and high RES penetration (wind, solar, hydro, biomass, geothermal, tidal etc.) in the energy mix. In **the decarbonisation scenario with high energy efficiency gains, no CCS and nuclear phase out**, energy efficiency improvements are considered as the most important option and

RES deployment is kept moderate. In **the decarbonisation scenario with high RES penetration, no CCS and nuclear phase out**, RES deployment is considered as the most important option and energy efficiency is considered comparable to the basic decarbonisation scenario. In **the decarbonisation scenario without transport electrification**, all other options are available as in the basic decarbonisation scenario. As a variant, **the decarbonisation scenario with delayed EU climate action until 2030** assumes the current GHG and RE targets until 2020 but in the decade 2020-2030 no further climate action is implemented apart the ETS regulations. After 2030, the EU decarbonisation effort is intensified in line with the specifications of the basic decarbonisation scenario so as to deliver the overall carbon budget (2010-2050) as specified for the series of decarbonisation scenarios. All emission reduction options are available after 2030 and are optimally deployed. Lastly, another variant, **the decarbonisation scenario with delayed EU climate action until 2030 without CCS and without nuclear**, is considered.

At an international level, the analysis is based on a set of scenarios that are characterised by different climate action for front runner regions – the EU alone or the EU and China jointly – and the rest of the world (Kriegler, Riahi, Petermann, et al. 2014 Table 5). The **no-policy baseline scenario** (Base) represents a counterfactual case in which no future policies dedicated to climate change mitigation are pursued. **The reference policy (RefPol) scenario** tries to capture main elements of the current climate policy landscape by including emission reduction commitments and renewable or nuclear energy technology targets at the level of 25 world regions and major emitting countries. The RefPol scenario tries to capture the reference development based on existing or planned policies. **The benchmark immediate action scenarios** aim to reach atmospheric GHG concentrations at levels of 450 ppm and 550 ppm CO2 by the end of the century. Global cooperation toward these goals starts immediately. In **the staged accession scenarios**, the EU (or China and the EU) as front runner successfully motivates the other regions to join an ambitious climate regime in 2030. As a single front runner, the EU adopts the climate roadmap immediately, while the others follow their reference policy or no climate policy at all until 2030. In **reconsideration scenarios**, the front runners are unable to motivate other regions to transition to a more ambitious global climate regime, and as a result reconsider their own stringent mitigation action. They transition back to the reference policy over the period 2030 to 2050, while the others follow the reference policy throughout the 21st century.

Link: Access to the AMPERE scenario database: *https://secure.iiasa.ac.at/web-apps/ene/AMPEREDB*

Time Horizon: 2030 and 2050.

Geographical focus: world and Europe

Scale: global, regional

Relevance for urban Post Carbon Futures:

The AMPERE policy scenarios potentially can provide a global / European policy background and connected economic assessments for post carbon strategies at an urban level.

CECILIA 2050

CECILIA2050 is an ongoing joint EU project that aims at providing scenarios and foresight exercises in support for European climate policies. Different sets of scenarios have been produced, based on economic modelling (De Koning, Huppes, and Deetman 2014), and one representing a form of back-casting exercise, The insights provided by these exercises can be used as one of the starting points for assumptions about future where post carbon cities will live.

- Low carbon scenarios, use data on Energy Technology Perspectives provided by the International Energy Agency (IEA) in 2012 (*http://www.iea.org/etp*) for GDP, Population and projections on household sizes (three scenarios: Reference, fragmented policy and policy success)

- Climate policy scenarios Business-as-usual scenario, Technology scenario 2050 (emission reducing technologies added, including CCS); Two degrees scenario 2050; in search for further options to reach 80% emission reduction)

Time horizon: 2050

Sectors covered: climate change, policies

Geographical focus: European (with global/local components)

Scale: (global/regional/national/local) Regional (EUROPE)

Relevance for urban Post Carbon Futures:

Cecilia publications and documents can potentially be used as one of the starting points for assumptions about future where post carbon cities will live. Publications actually available are limited to considerations of optimal policy mixes for climate policy instruments and baseline analysis of some European national contexts on behalf of existing climate policies adopted.

GLOBAL ENERGY ASSESSMENT

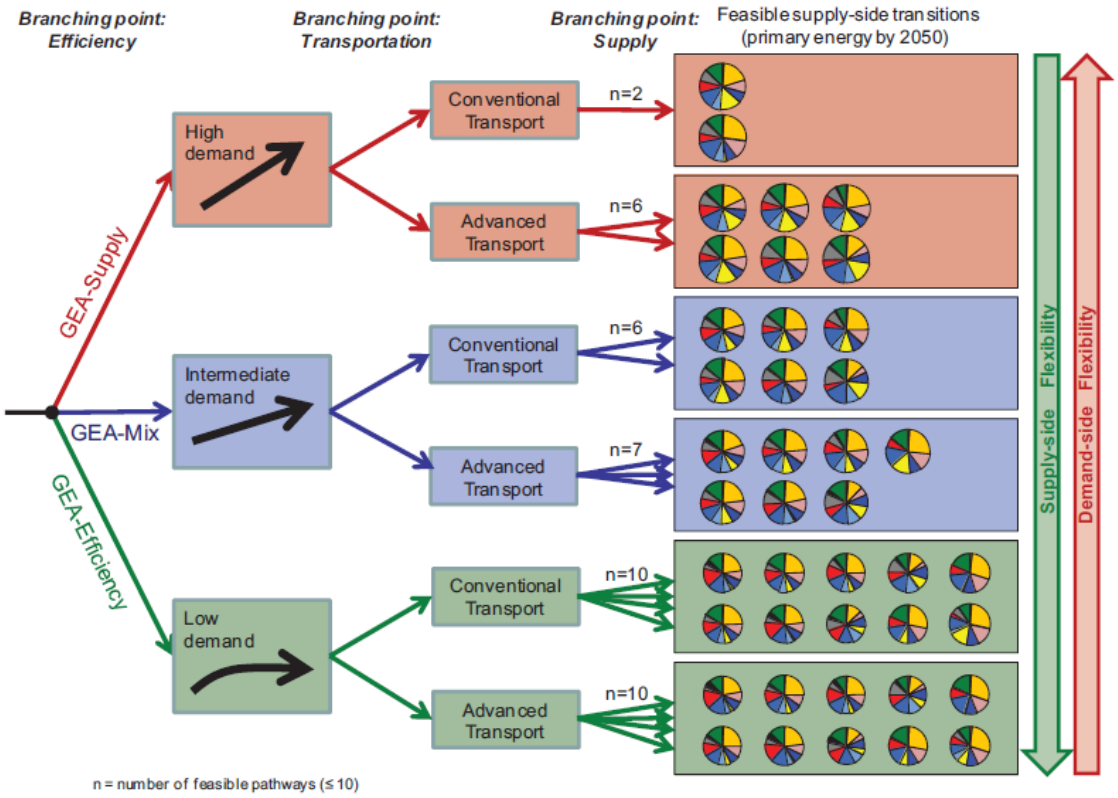
The Global Energy Assessment (GEA 2012) developed global scenarios as well as sectoral outlooks. The GEA estimates that between 60–80% of final energy use globally is urban. The assessment stresses that from all the major factors determining urban energy use – climate, position in the global economy, consumption patterns, quality of built environment, urban form and density (including transport systems), and urban energy systems and their integration – only the final three are important to policymakers of cities, at least partially.

Therefore, the GEA states that both in terms of leverage and potentials, energy policy at the urban scale needs to primarily focus on demand management with emphasis on energy efficient buildings, structuring urban form and density conductive to energy efficient housing forms, high-quality public transport services, and to urban energy systems integration. The report notes that this demand-side focus at the urban scale represents a paradigm shift compared to the traditional, more supply-side energy policy focus at the national scale.

GEA Scenarios

The GEA developed three energy transition pathways with two main features: (1) they focus on energy issues and (2) they have a normative nature; this means that their objective is to describe alternative, but successful, pathways toward a transition to sustainable energy systems. In the GEA, scenario pathways are outlined to successfully address current widespread economic and energy disadvantages of poor rural populations. One of the scenarios assumes, for instance, universal energy access to be realized by ca. 2030. The qualitative scenario storylines describe developments in which the pressure for rural to urban migration is significantly lowered .

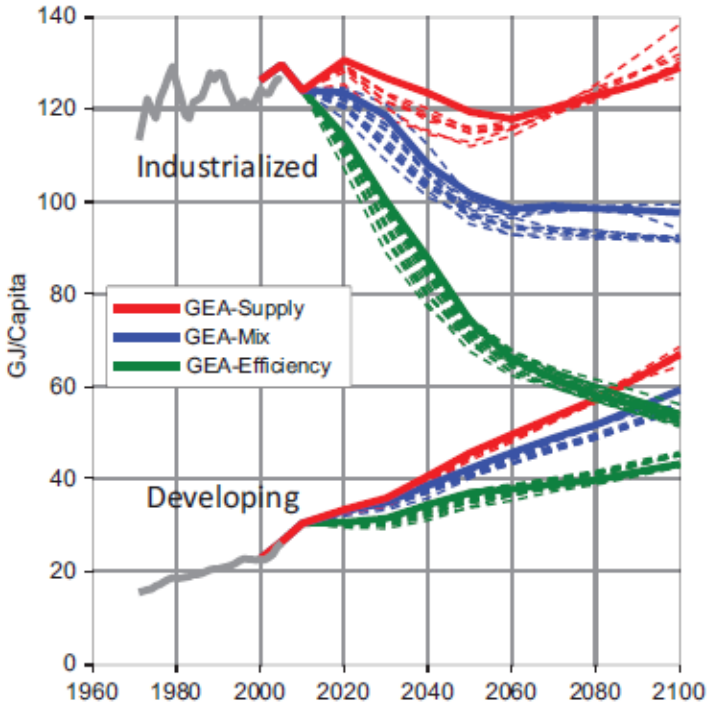
Figure 7: Assumptions underlying the three GEA scenarios



Source (Riahi et al. 2012)

The scenarios GEA-Supply, GEA-Mix, and GEA-Efficiency explore the potential outcomes of different sets of strategies increasing efficiency to achieve ambitious targets for sustainable development. The ambitiousness of the targets defines the feasibility threshold for combinations of supply and efficiency measures. High levels of efficiency improvements, as assumed by the GEA-Efficiency pathways, increase the supply-side flexibility to reach the targets, and interventions on the supply side increase flexibility in order to achieve reductions in energy demand.

Figure 8: Historical and projected per capita final energy use



Source: (Riahi et al. 2012)

As Figure 8 above shows, the GEA scenarios significantly differ in per capita energy demand for industrial as well as developing countries.

The scenario GEA-supply uses the UN Urbanization Prospects projection directly as input. The other (lower) scenarios (GEA-mix and GEA-efficiency) adopt the methodology outlined in Grübler et al.(2007) using a model recalibrated to the most recent (2010) UN urbanization data. GEA-supply scenario assumes largely unaltered patterns in rural and/or urban locational advantages while GEA-efficiency on the other side assumes an impact of successful rural development policies that relieve urban migration pressures.

The GEA also proposes alternative accounting approaches to the current 'production' based accounting approach, in which emissions are accounted for in the country (or city) where they are produced. This contrasts to a 'consumption' accounting approach that allocates energy uses to (urban) consumers irrespective of the form energy is used (direct or embodied energy) or its location (within or outside a city's administrative boundary). Available consumption-based energy accounts for cities currently are limited (estimates exist for only a handful of megacities). The GEA reveals a large heterogeneity in urban energy-use patterns drawing together a new data set for urban energy use. In many developing countries, urban citizens use substantially more final energy per capita than rural citizens, reflecting the income differences between urban and rural areas. For industrialized cities on the other hand, the GEA reveals that in many industrialized countries the per capita final energy use of city inhabitants is often lower than the national average, reflecting the effects of compact urban settlements, settlement types (multi- versus single-family dwellings) and availability and/or practicability of public transport infrastructure systems as compared with those in the suburban or rural areas . The GEA conclude based on the few available data, however, that urban energy use in high-income countries is not substantially

different from the national average when using a consumption-based accounting approach. In low-income countries however the urban-rural energy difference is likely to be even larger under the consumption based accounting method. The GEA finally concludes that both accounting methodologies are complementary, and provide valuable information to inform urban policy decisions.

Time horizon: The time horizon used for the scenarios is 2050. The base year for the scenarios is 2000.

Driving forces: Transformational policies for the demand- or supply-side of the energy system

Sectors covered: Buildings, transport, industry, separate assessment of urban systems

Geographical focus: Global and regional

Relevance for urban Post Carbon Futures:

The GEA doesn't only provide global energy scenarios but gives insight into the complex drivers of urban development. Also it considers an consumption based accounting of greenhouse gases that may become increasingly relevant for post Carbon futures.

III.III.2 ECONOMIC AND SOCIAL CHALLENGES

FLAGSHIP

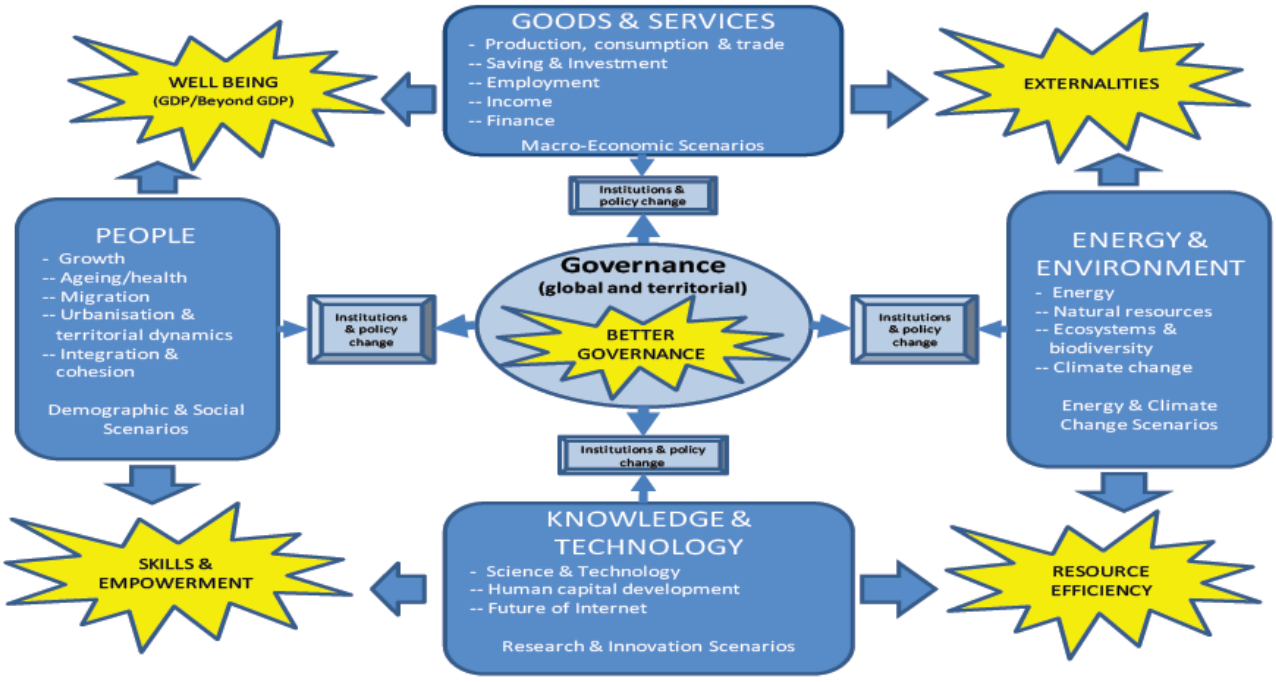
The FLAGSHIP research project, funded by the European Commission, started in 2013 with the aim of developing a "Forward Looking Analysis of Grand Societal Challenges and Innovative Policies". The project intends to explore major challenges for European policies in the next 20-30 years, assessing in particular, potential impacts of present trends in demography, economy, politics and technological development. These trends are assessed for the European member state on the background of a global development. The project has identified three major challenges:

- **Environmental challenge**: current trends of over-exploitation of essential natural resources;
- **Societal and economic challenge**: political, cultural, demographic and economic transformations driving the need for developing a knowledge-based society;
- **Governance challenge**: governance both in the EU and at a global level will need to develop towards greater transparency, and increased accountability, .

These challenges will be considered in their global geopolitical context. The FLAGSHIP scenario exercise aims to support European policy makers addressing environmental, social and economic and governance challenges. The foresight exercise will have potential impacts generated by innovative policies and of selected global governance scenarios.

The FLAGSHIP Foresight exercise focuses on four thematic areas (people, goods/services, energy and environment, knowledge/technology) which are assumed to be key issues to be dealt with at the level of global/territorial governance. They are linked to five critical transition challenges, visualised as stars in Figure 9.

Figure 9: Flagship forecast concept

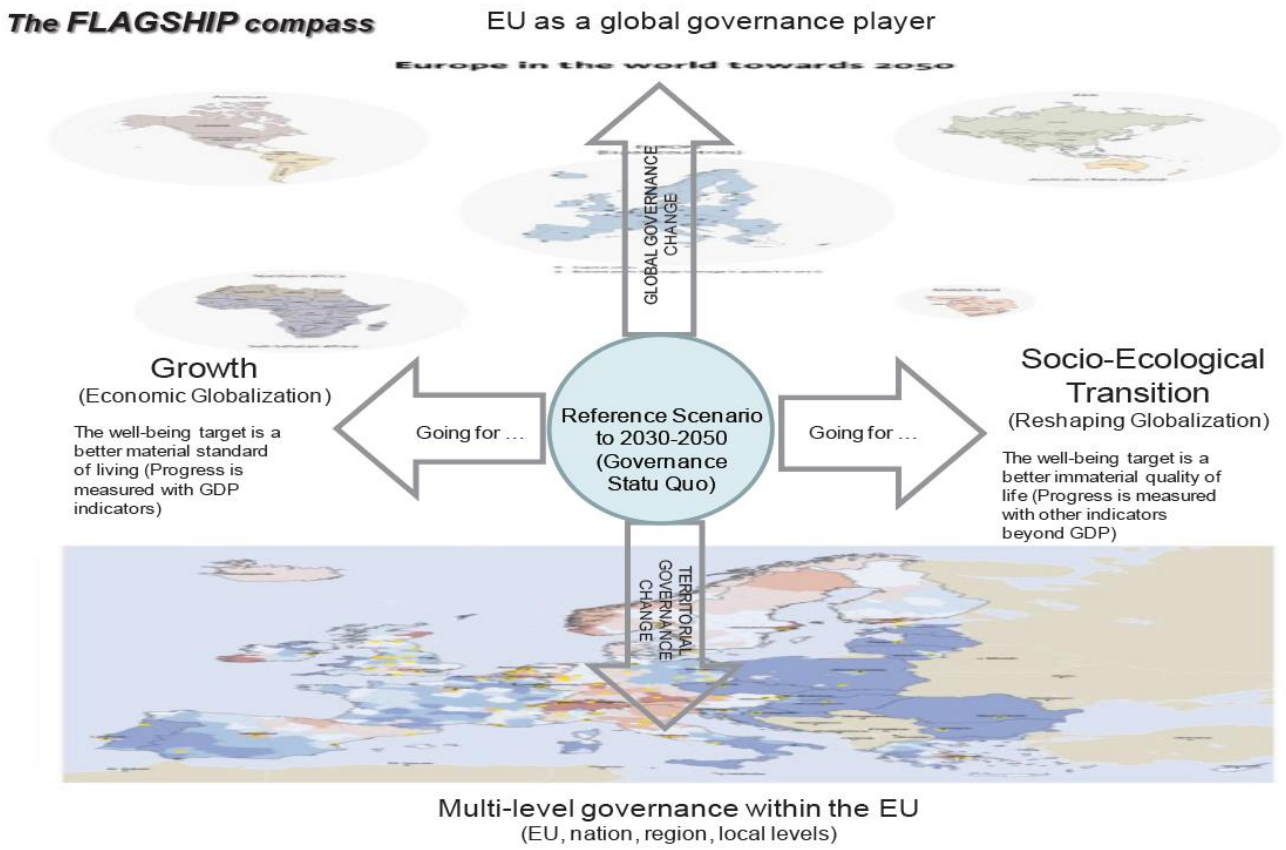


Source: (Flagship Consortium 2014)

The foresight exercise for FLAGSHIP will be framed by a global reference scenario for the timeframe of 2030-2050 which will be elaborated to provide forecasts for trends in crucial economic, social and environmental variables. Additionally, detailed reference scenarios will be elaborated. This reference scenario is the starting point for the development of potential future trends following two main axes: the sustainability dimension on the horizontal axis and the governance dimension on the vertical axis.

The sustainability dimension has two poles of “Going for growth” versus “Going for socio- ecological transition”. The “Going for Growth” trend is oriented at the OECD global outlook exercise and follows the conventional economics view which aims at maximizing material living standards, the flow of goods and services and aims at structural reforms to boost real income for all OECD countries (increase GDP/capita.).

Figure 10: Flagship scenario axes

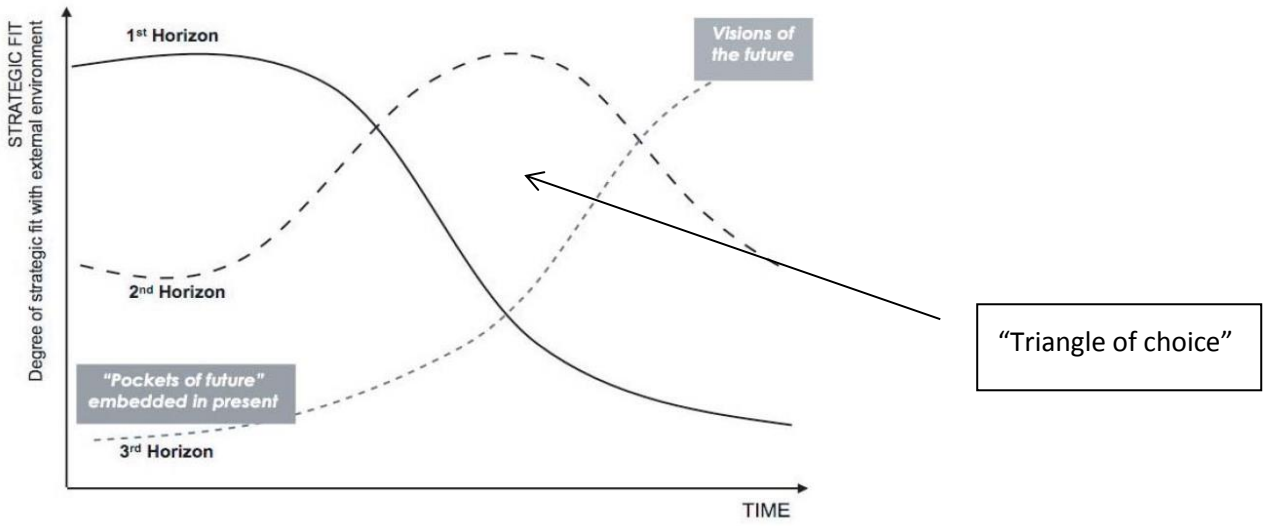


Source: (Flagship Consortium 2014)

The trend called "Socio-Ecological Transition" aims at the reshaping of economic globalization, based on the view that an agreement on basic values such as respect of human dignity and basic human rights is needed. These "Alternative Consensus" principles are assumed to contrast neoliberal values insofar as they state that trade and investment have to contribute to desired social effects (healthy, respected and sustainable communities); certain essential goods and services should not be traded or patented; ecological sustainability is a key element; and the shift towards eco-design principles in the industrial system is a must.

The governance dimension on the vertical axis has two opposite paths of "global governance" vs. "territorial governance". The first path sees Europe as a global governance player, driven by major possible changes in European and global institutions and rules for government with a transfer of power from the national to higher level institutions. The opposite path called the "territorial perspective" aims at approaches to multi-level governance increasing cohesion and sees EU sectorial policies having a territorial dimension enforced.

The methodology to build the qualitative scenario storylines uses the **"Three Horizons Model"** (Curry and Hodgson 2008) as a way of addressing uncertainty.



Source: Scheme of the futures-oriented Three horizons model (Curry and Hodgson 2008)

According to the authors of the model, three levels or horizons can be distinguished, with *Horizon 1* representing the space of the imminent future, the prevailing system as it continues into the future. *Horizon 3* is the space of possible futures, where powerful and compelling visions, that perhaps seem marginal in the present (pockets of the future), are described. There can be more than one 3rd horizon vision. *Horizon 2* is the intermediate space of transition, where both are possible: it can be designed either on a *forecast* - using implications of present-day trends and potential drivers of change- or on a *back-cast* inquiring on actions and strategies that would have been required to create the conditions for the aspirations and vision of Horizon 3.

This model yields, between the curves of the different horizons a "triangle of choice", i.e. potential future spaces where policy and strategy conflicts happen. The qualitative scenarios developed by this methodology will be complemented by quantitative scenarios being elaborated for different areas identified for the grand societal challenges, using models for financial, economic *development* and innovation (e.g. the *NEMESIS model*) demographic and societal change (*FLAGSHIP population projection model*); for environmental transformations (*EXIOMOD model*); and of changes in global and territorial governance (using a specific set of indicators for the analysis of governance trends developed by the *FLAGSHIP project*).

Time horizon: Not sharply defined; 2050 as horizon of the model

Sectors covered: All GSC (Grand Societal Challenges) relevant fields, scenarios covering mainly demographic, legal, economic, social and political evolutions

Geographical focus: Europe

Scale: European

Relevance for urban Post Carbon Futures:

As FLAGSHIP has started only recently, it is difficult to assess the importance of this extremely complex approach for urban Post Carbon Futures. Although issues and challenges are treated at a global scale, and sectors might be rather general to be of considerable importance for this purpose, the chosen 4 thematic

areas (people, goods/services, energy and environment, knowledge/technology), and the 5 critical transition challenges could also be applied at the urban level.

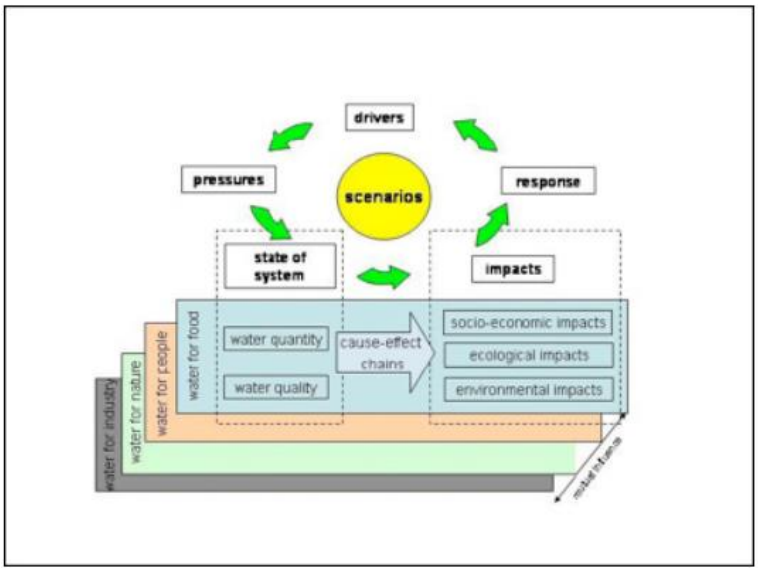
III.III.3 WATER POLICIES

SCENES

The project SCENES "Water Scenarios for Europe and for Neighbouring States" was a 4-year EC FP6 research project that started 2006. Its aim was to develop and analyse a set of comprehensive scenarios describing future development of freshwater quality, availability and for related policy in Europe up to 2050. The project area covered extended beyond the area of the European Union, reaching to the Caucasus and the White Sea, and including southern Mediterranean rim countries of North Africa and the Near East. SCENES was tasked to consider existing scenario development methods and innovate to improve them in a "learning-by-doing" participatory process including stakeholder workshops. Within an iterative process the quantified parameters and the quantitative models were improved.

The SCENES approach tried to combine different dimensions of water futures (social, cultural, economic, climatic, hydrologic,..) and to combine qualitative with quantitative scenarios. The qualitative ones served to provide –via storylines - a consistent picture how water resources (in the chosen areas) may develop in the given time horizons: Present to 2015; Middle 2015-2025; and End 2025-2050. Complementary to that, quantitative data of state of the art models provided numerical information and showed certain trends.

Figure 11: SCENES Impact analysis



Source: ("CESR - SCENES PROJECT - Impact Analysis" 2014)

SCENES used the widely known *DPSIR scheme* as a conceptual framework for its assessment. DPSIR is putting together indicators for driving forces (D), pressures (P), states (S), impacts (I) and responses (R)). SCENES additionally added indicators for socio-economic aspects and water systems services.

The scenarios developed by SCENES addressed the future state both of water quantity and quality of Europe's rivers, lakes and wetlands, resulting from the pressures produced by the driving forces analysed.

The following human activities which directly affect availability, demand and quality of water as **pressures** have been considered: BOD[10] loadings (diffuse, domestic, manufacturing, scattered settlements, urban runoff), Irrigated area, Land use changes and Thermal electricity production.

(Socio-economic) Developments that influence water resources, water quality and water demands - **driving forces** – may lead to increasing water withdrawals and wastewater discharges and are: Gross Domestic Product (GDP), Gross Domestic Product per capita (GDP/cap), Gross Values Added (GVA), Irrigation project efficiency, Livestock numbers, Population, Precipitation, Structural change, Technological change, Temperature, Treatment level and connection rates.

State: the assessments were quantified using data bases and numeric models, providing images of plausible future states of Europe's freshwater resources. These quantitative scenarios complemented the storylines of qualitative scenarios by providing numerical information and showing trends. Based on the global water model WaterGAP numerical information for water availability, water quality and different water use sectors was provided. This model considers also climate change impacts and socio-economic drivers at a European level.

As for the **impact** analysis, the SCENES project distinguished **generic hydrological impact indicators** and **impacts on four water system services**:

- Water for Food: Water used in the agricultural sector
- Water for Nature: Water availability and water quality for biodiversity and ecosystem health
- Water for People: Drinking water supply, quality of bathing waters, flood protection and water scarcity
- Water for Energy and Industry.

The scenario development was methodologically based on the *Storyline-and-Simulation method*. The narrative storylines for the Scenes scenarios were developed of during three rounds of pan-european Stakeholders' workshops. The circa 30 stakeholders were recruited among water experts from around Europe, including representatives from the private sector, policy, scientists, and non-governmental organisations.

The scenario development followed a two phases approach:

I) Phase I In a 'Fast-track' exercise at the pan-European scale existent scenarios and readily available information on drivers and policies were selected and combined with a quantitative model of water availability and uses in Europe.

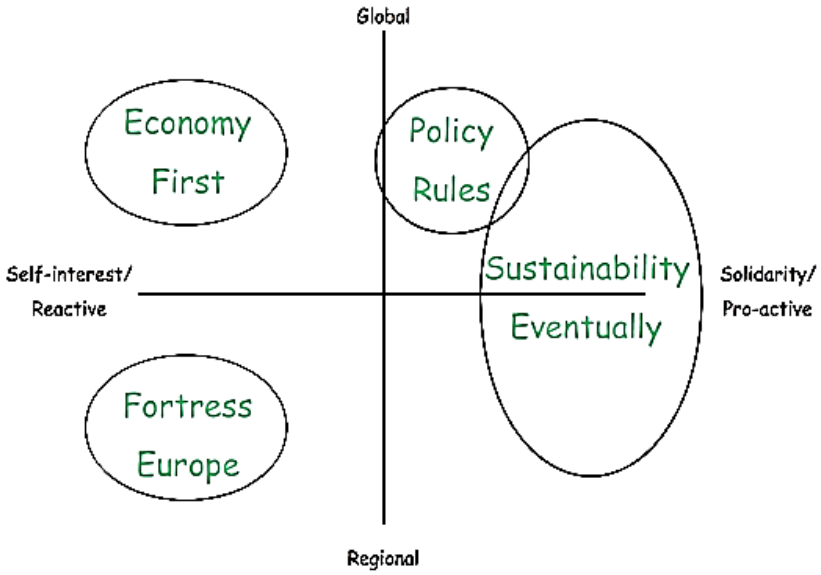
II) Phase II these scenarios were refined at all scales, based on feedback from the panels which led to a deeper analysis of drivers and policy issues and to model outputs for water availability and use. Given the final image, water strategies were developed through back-casting.

Four scenarios were developed and subsequently translated to quantified parameters in order to serve as input for the quantitative water model.

The storylines used in the SCENES project focussing on water issues, were derived from UNEP's 'Fourth Global Environment Outlook' (for a description of the four scenarios see par. III.II.3 UNEP Global Environmental Outlook), highlighting the specific implications of each of these scenarios for water policies.

[10] Biological oxygen demand (BOD) is an indicator of the level of organic pollution and its oxygen-depleting potential

Figure 12: SCENES Storylines



Source: ("CESR - SCENES PROJECT - Results" 2014)

Economy First Scenario: Characterised by globalisation and liberalisation, income inequality, immigration and urban sprawl, this scenario assumes a growing need and price for water especially caused by (mainly food and fuel) production needs and increasing social tensions. It's only at this moment that better cooperation of stakeholders takes place.

Policy Rules scenario: Starting from a first period of strengthening the role of European Commission and Parliament while struggling for political integration, policies become less effective in the medium-term because of production costs and water consumption patterns. Disparities lead to regional pressures. Finally, the effective deterioration of ecosystem services related to water has the effect that policies to de-carbonise Europe and to expand river basin planning may be implemented.

Fortress Europe scenario: The world becomes increasingly unstable due to crises in all sectors. EU policies in search for security against these threats result in protectionism and self- sufficiency policies. Due to the increasing strength of EU institutions, the EU manages to ease most conflicts within its borders. On the long term, this leads to a need for increased production, combined with out-dated technologies and little attention to environmental consequences, causing a strong pressure on domestic natural resources. Raising internal conflicts are solved by the strong EU institution.

Sustainability Eventually scenario: Disasters, consumer mistrust in politics and migration, top down measures characterize the present. Scientific resource related Knowledge is improved, alternatives are still weak. Very slowly behaviour changes happen, bottom up trust-based networks are formed. Still top down governments are more effective. A painful transition process leaving very strong old structures starts (regionally). Technologies develop. In a final period, EU still exists, fostering and stimulating local action, but the lead is taken by trust-based local networks. Strong regional differences remain. Behavioural changes become apparent; consumption patterns change.

Time horizon: Three periods: 2008-2015; 2015-2030; 2030-2050

Sectors covered: Water, linked to the socio-economic, political and ecological system

Geographical focus: Europe

Scale: (global/regional/national/local): Pan-European, regional and pilot scales (4 case studies)

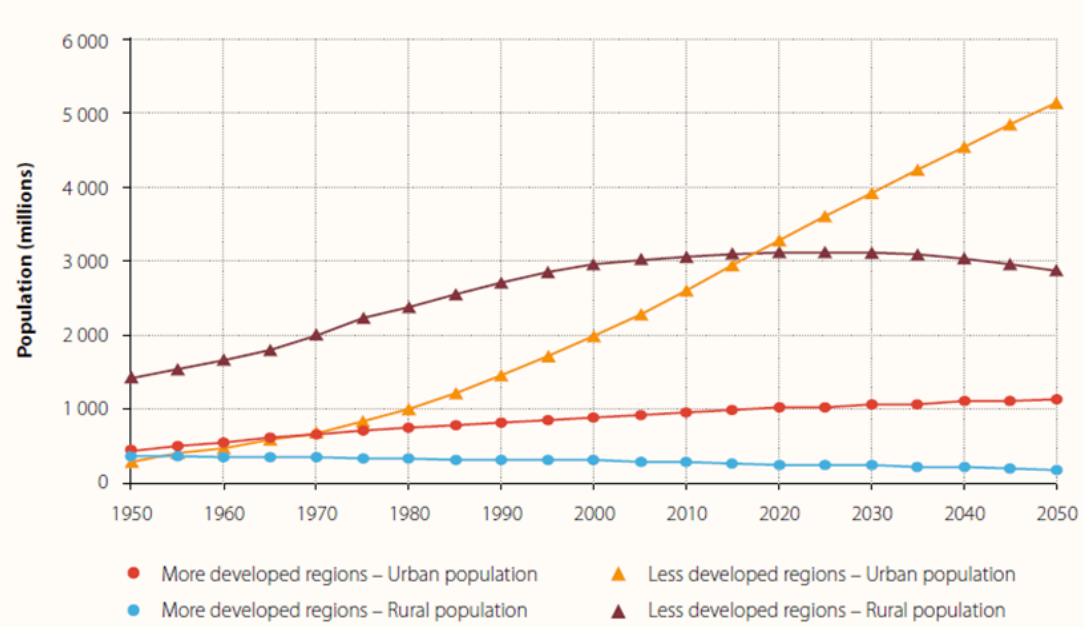
THE UN WATER DEVELOPMENT REPORT 2014

The UN water development report published in 2014 (UNESCO - WWAP 2014) doesn't contain scenarios but trends and drivers that may be relevant for POCACITO. The report analyses existing and projected interdependencies between the management of water and energy, including the water–energy nexus, and applies this also to the urban context. Albeit focussing on countries of the developing world, some features will be relevant also for POCACITO Case study cities, especially those in the European South.

The report outlines that, if no sustainable resource management practices limiting the impact of wasteful consumption are being applied, economic development is bound to impact negatively on both quality and quantity of water supplies. Increasing water demand and overexploitation of freshwater resources is driven by consumer demand and increasing standards of living, mainly by middle income households in developing and emerging economies. In these countries, the demand for food, energy and other goods is increasing, and the production of these goods and services requires significant quantities of water. From data obtained from the FAO's global water information system ("AQUASTAT - FAO's Information System on Water and Agriculture" 2014) it can be estimated that, between 1987 and 2000,, freshwater withdrawals have increased globally by about 1% per, This trend which is due almost exclusively to an increasing demand for water in developing countries (whereas consumption of freshwater is declining in the most developed countries) continued at a similar rate to the present. To the extend to which desalinization is used for meeting water needs, energy consumption related to freshwater provision is boosting.

With regards to urban areas, growing urban populations and their increasing affluence generally lead to higher energy and water consumption for domestic use. Although water consumption per capita generally increases with affluence, this growth is assumed not to continue in a linear way, as, at higher income levels improved water conservation measures can be employed in homes, water losses and leakage reduced and awareness among consumers enhanced. Nevertheless, it will become increasingly difficult and energy intensive to meet the urban water demands, as most low cost sources of surface and groundwater water have already been depleted or contaminated and urban population will increase mainly in urban areas of developing countries, which will absorb more than 90% of the global population growth (United Nations Human Settlements Programme 2012)

Figure 13: Urban and rural populations by development group, 1950 - 2050



Source: (UN-DESA 2012, 3)

Water provision is energy intensive, as actually between 5% to 30% of the total operating cost of water and wastewater utilities are due to energy costs (The World Bank 2012), but in some developing countries such as India and Bangladesh, energy costs account for as much as 40% of the total operating cost (van den Berg and Danilenko 2010).

with growing cities, water demand per capita is expected to increase rapidly, but, there is also the potential for restricting this increase or even to reduce it by using water conservation measures. Especially in the rapidly growing cities of developing countries, energy supply will therefore have direct implications on availability as well as affordability of water in in the future.

The relationship between water demand and energy use can be presented in a three phases model (Novotny 2012) which exemplifies how in some US cities simple strategies like the introduction of efficient water appliances, reduction in leaks and dry landscaping (i.e. xeriscaping) could reduce up to 65% of water demand and energy consumption. In a second phase, water supply could be enhanced using through additional sources and treating and reusing storm water, although this enhancement will not be accompanied by a significant decrease in energy demand. Advanced water treatment options implemented in a third phase (reverse osmosis water recycling systems and desalination plants) could be employed, systems that are energy intensive, but can offer a reliable source of water and their additional energy inputs may be reduced by the use of efficient technology and renewable energy sources.

Time horizon: 2050

Sectors covered: agriculture, industry energy production

Geographical focus: Global

Scale: global and EU

Relevance for urban post Carbon Scenarios:

The study sheds light on trends and interdependencies for future water policies and their connection to energy consumption, highlighting features that are of particular relevance for the POCACITO case studies.

III.III.4 TRANSPORT POLICIES

TRANSVISION

TRANSvision (Petersen et al. 2009) presents a study which has developed a set of long-term foresight exercises (time horizon 2030) and exploratory scenarios (time horizon 2050) for the assessment of transport and mobility in Europe.

Scenarios of different types are developed for two different timelines: the foresight exercise for 2030 is based, further to a baseline scenario, on two economic growth scenarios. Both economic growth scenarios (low and high economic growth) are integrated by a policy scenario, where developments are to some extent modified by policy interventions. The basic assumptions underlying these scenarios refer essentially to projections regarding population growth an demography, GDP and fuel prices made by international organizations (these developments are translated into drivers for the scenarios in terms of transport costs (which are a result, inter alia, of technological efficiency), and development of networks.

The exploratory scenarios for the time horizon 2050 are based on proper storylines, intending to introduce surprising elements into the consideration of possible futures. The intention is to tell " … an appealing story that is not easily dismissed by experts ad policy makers" (Petersen et al., 2009). The distinction between scenarios follows specific patterns of mobility and concepts of mobility, but elements of the archetypical scenario storylines introduced earlier (see paragraph III.II.1 on the Millennium Ecosystem Assessment, Scenario and par III.II.4 on the OECD environmental outlook) have been used for distinguishing specific socio-economic trends and policies:

- **"Moving alone"** or „Induced mobility" is a storyline focusing on high investments in new technologies, markets, and market oriented policies, sustained by strong economic growth, but with some problems of sustainability with regards to social issues, whereas CO2 emissions are reduced due to technical efficiency.
- **"Moving together"** or „Decoupled mobility" is a storyline focusing on strong social sustainability, where policy interventions aim at cost-effective policies and institutional change. There is a gradual, cost-effective process to reduce CO2.
- The **"Moving less"** or „Reduced mobility" scenario emphasises social and environmental values, with policies aiming at behavioural changes, alongside with land use changes and increase in public transport. The storyline is based on an assumption of low economic growth rates and assumes long distance traffic flows being reduced as the role of local communities is enforced.
- **"Stop moving"** or „Constrained mobility" is a storyline where the element of a surprising event is implemented, assuming the transport system to reach a "bottleneck" after a first short period of strong economic growth. Later, a turning point in development is reached because of structural reasons introducing a surprising development (turning points can consist of lack of public investment in infrastructures or new technologies or a strong economic decline). Mobility is regulated, in order to reduce congestion and emissions.

Time horizon 2030, 2050

Sectors covered: economic growth, transport policies,

Geographical focus: Europe

Scale: (global/regional/national/local?**)**

Relevance for urban Post Carbon scenarios:

The scenarios describing social and economic drivers for changing mobility patterns have a great potential interest for POCACITO urban futures, where future forms of transport are of crucial importance for the design of future cityscapes.

III.III.5 URBAN POLICIES

TOWARDS POST CARBON CITIES: WHY? HOW?

In 2008, the French Ministry of Sustainable Development and the French Environment and Energy Management Agency (ADEME) launched the research programme "Rethinking cities in a post carbon society", which aimed at analysing the role of cities in the post carbon transition using, inter alia scenario building. The scenario building process yielded six different scenarios, organized along two main axes: the degrees of flexibility, indicating the range of actions local authorities were assumed to be able to undertake, and the innovation context in which the actions are framed (Theis and Vidalenc 2013; Theys and Vidalenc 2013).

Table 4: Schematic representation of post carbon cities scenarios

DEGREES OF FLEXIBILITY – POSSIBILITY OF ACTION			
Context	**Major role of context (Limited possibility of action on technologies and price signals)**	**Possibility of action on investments and infrastructures**	**Possibility of action on urban planning, and lifestyles**
Baseline (trend)	**Scenario 1** Intelligent wait-and-see	**Scenario 3** New climate and energy infrastructures	**Scenario 5** Self-contained city
Radical change favourable to innovation	**Scenario 2** Carbon creativity	**Scenario 4** Biopolis	**Scenario 6** Frugal Urbanity

- **"Intelligent wait-and-see":** The logic of this scenario is to continue, in a difficult context, to carry on actions with little financial resources. Creativity, imagination, organisation, reactivity and opportunism are central. In this scenario, transition is radically forced when a certain point is attained following a waiting position of all actors. Cities have a very low leverage potential and react too late to the situation.
- **"Carbon creativity":** In this scenario, price signals and taxes are used as tool to create opportunities. It is a scenario based on industry policy. National industries will lead the transition to new technologies. The logic here is economic rationality. Cities have only little room to act, but are able to invest in innovation like the development of networks for electric vehicles. Social inequalities increase.

- **“New climate and energy infrastructures”:** Investment in cities is at the heart of the energy transition in this scenario. Four directions are privileged: Energy retrofitting in housing, local energy production, climate adaptation measures, investment in public transport infrastructures. National state has a voluntary strategy and help financing big infrastructures projects. This scenario is highly centralised. Cities, though, have a central role in reacting to public investment. Inequality increase between city and periphery.

- **“Biopolis”:** Biopolis is a hybrid of city and nature uniting city and countryside. With much more extensive powers in energy, local authorities undertake, at the level of larger urban areas, and with all local stakeholders and citizens, proactive policies to enhance their territory and their resources in a context of autonomy and "gently green". Cities are regenerative. Energy management is decentralised. Private property is still essential even though new forms of mutualisation and cooperation emerge.

- **“Self-contained city”:** In a perspective of sustainable development, local authorities, taking advantage of an institutional and fiscal framework, engage in ambitious political organization of their territory and mobility (transport infrastructures), to enable the relocation of activities and housing and draw a denser, organized and accessible city. Planning tools are integrated with climate protection strategies. Land is managed as to keep prices low. Tax strategies take into consideration the localisation of activities and housing. Urban sprawl is addressed through land-use policies.

- **Scenario 6: Frugal Urbanity:** In a context marked by strong social concerns, and rapidly increasing concerns about climate and energy prices, the state, business, civil society and local authorities accompany a deep transformation of lifestyles and consumption as well as development patterns – in the perspective of more sober and more resilient cities which are better able to meet a renewed "urbanity" desire. In this scenario, a major transformation of lifestyle and consumption patterns has occurred in order to address climate and energy issues. 5 paths lead this scenario: (1)necessity, (2)incitation, (3)private initiative, (4)change of values and (5) social and urban policy. Change results from all factors (bottom-up as well as top-down, market and public policies).

Time horizon: 2050

Sectors covered: Urban development

Geographical focus: France, applied to urban areas

Scale: urban areas in France

Relevance for urban Post Carbon Futures:

This scenario exercise made with an objective which is largely convergent with those set by the POCACITO project, was made for the French policy context and with collaboration of French city planners and stakeholders. It represents an inspiring example of the potential facets such an exercise can have and the directions urban scenarios potentially can explore.

IV POCACITO STORYLINE FOR EUROPEAN URBAN FUTURES

Based on the analysis of the scenarios available in the literature, the POCACITO Consortium decided to choose the SSP2 among the Socio-economic pathways formulated in the context of the most recent Assessment report of the IPCC (Krey and Masera 2014, see also par. III.II.5) as basis to build the background scenario for the POCACITO local low carbon visions in the case study cities. Keeping the background scenario for the POCACITO exercise as close as possible to a "business as usual" development implies that local low carbon visions will indeed need to stress the element of "rupture" with the general policy context in developing a post carbon strategy rather than being triggered by national or international policies, furthermore external signals such as technological change or price signals will play a minor role for pushing forward the transition process.

The chosen pathway, SSP2, represents a "business as usual world", where present developments are assumed to continue like in the recent decades. This pathway assumes that national economies are functioning in a stable manner, and national states remain politically stable with globally connected markets and per capita income levels growing at a medium pace. Similar assumptions are made for global urbanization trends, alongside with similar "middle of the road" assumptions about population growth, technological change, and economic growth. In high income OECD countries, urbanization rate will continue growing slightly with all countries following the central urbanization pathway[11], although under various forms and patterns depending on their current practices and their present rates of urbanization. With Urbanization growth rates slowing down, cities will still need to manage changes and transformations due to on-going migration and increasing average dwelling areas per capita.

In terms of carbon intensity, overall fossil dependency is assumed to decrease only slowly, and climate change is confronting urban areas furthermore with new challenges of adaptation to a changing climate.

Population increase in most EU countries is due mainly to immigration rather than to natural fertility, adding integration of migrants onto the urban agenda of cities in industrialized countries.

IV.I RELEVANT DRIVERS FOR LOCAL VISIONS

The POCACITO experts identified external drivers that were considered relevant for the shaping of the local post carbon visions and conditioning urban development and transformation policies, and should thus be described in the background /framework scenario as factors that can potentially hinder or support policies for urban post-carbon futures. Some of these drivers can be influenced at least partially at the local level, but will require some specific action at local level.

IV.I.1 GOVERNANCE

In western democracies, local authorities have a relatively significant power for managing the local assets, and, as far as POCACITO work is considered, the term "local authorities" describes the governance level to

[11] Whereas globally the SSPs assume three different urbanization pathways (fast, central or slow urbanisation) for each country or part of the world, for European countries with their already high urbanisation rate, generally a central urbanisation pathway is assumed.

be addressed. Their effective power of these local authorities to influence urban shape, energy and transport policies varies nevertheless across European countries, as national legal and fiscal frameworks provide different grades of freedom to act to local authorities. In the context of the POCACITO scenario and visioning exercise, the actually available range of action for local authorities should be assumed as constant unless the extension of competences is recognized as a basic condition for taking action. In these cases precise definition of areas where an extension of competences at local level would be needed, could also be included into a specific local roadmap.

The same holds for public ownership of essential services: municipalities may actually be constrained by national laws driving the privatization of utilities, but there is a strong tendency to oppose this trend towards maintaining or regaining control over public services.

IV.I.2 SOCIAL VALUES

At the level of social preferences, social values and the aim of protecting common goods, which can translate into more sustainable lifestyles albeit connected to changes at a larger scale, can be influenced by rewarding sustainable behaviour, for instance by promoting sustainable transport and sustainable consumption patterns. A basic assumption of the background scenario is that these social values require economic and behavioural strategies to be transformed into sustainable lifestyle, many of these activities regard the every-day living environment, and are thus a field for local action.

IV.I.3 TECHNOLOGY AND ENERGY POLICIES

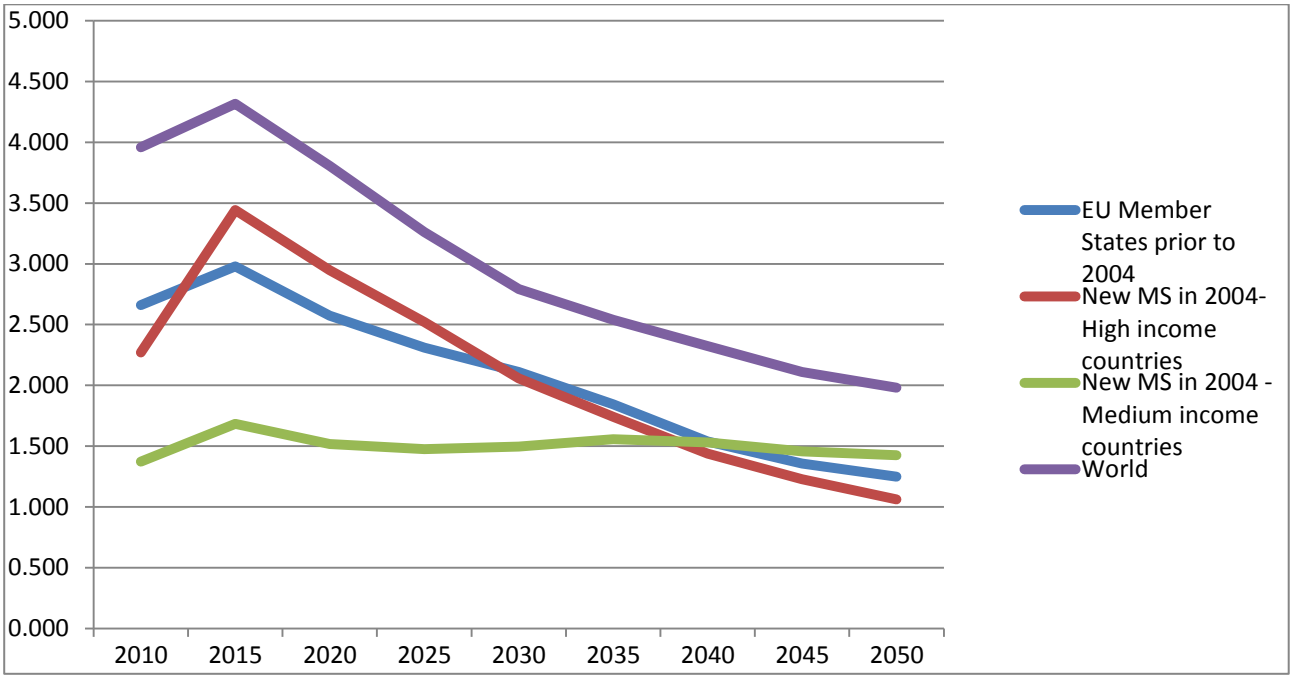
Drivers connected to technological change and innovation connected to energy efficiency and new forms of energy generation are widely dependent on external factors, which go, to a certain extent, beyond the national boundaries. Space for action at the municipal level is relatively restricted, although an industrial policy favouring innovation by testing and employing new technologies might increase the economic growth of specific sectors, in the urban area. The adoption of Best Available Technologies by local administrations may also help reaching the critical volume for their mass diffusion.

As far as Energy mix and resource efficiency are concerned, the local range of action is to a certain extent dependent on the national framing policies, but as far as local energy generation and private household appliances are concerned, there is some room for local action promoting energy and resource efficiency, organization of closed cycles, transport policies, etc.

IV.I.4 NATIONAL AND INTERNATIONAL ECONOMIC CONTEXT

The outputs from models provided in the context of the definition of SSPs, offer different perspectives on future economic growth under the SSP2, with potentially slightly different impacts on both household incomes and possibilities for investments in public infrastructures, and, furthermore, different impacts on “external” carbon footprints in terms of tourism and carbon leakage.

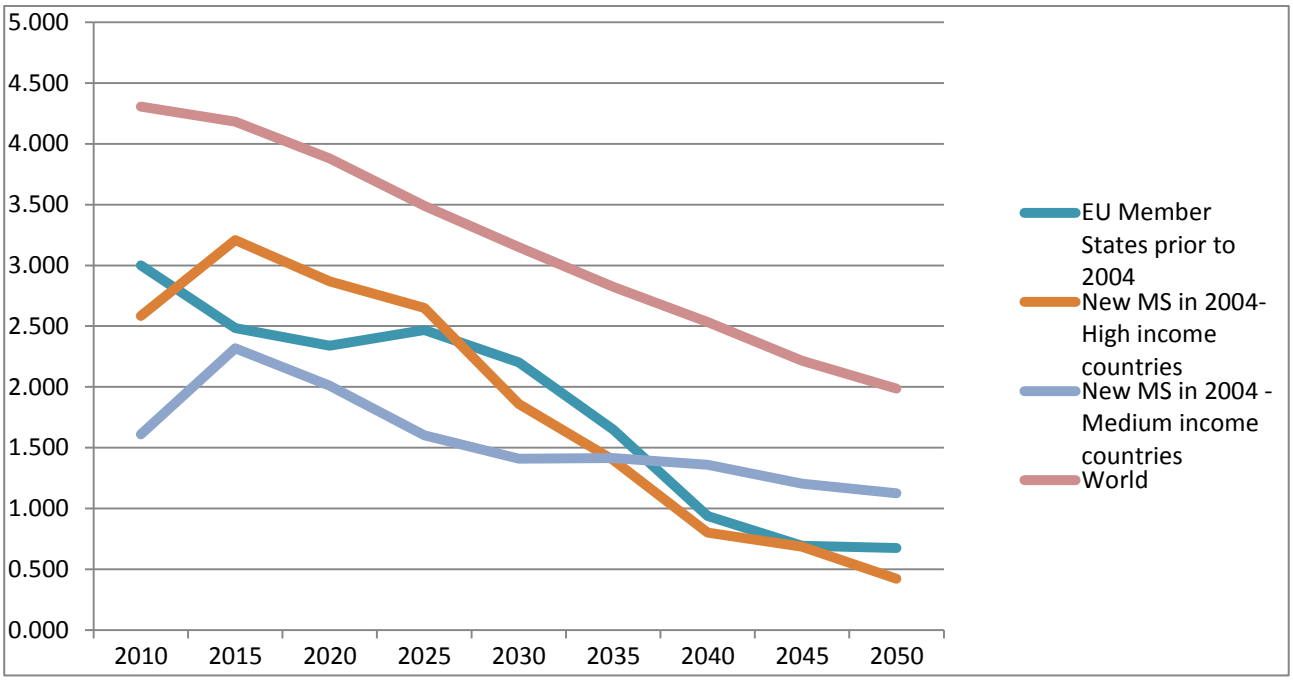
Figure 14: GDP/PPP according to OECD Env-Growth model (annual average growth rates in %)



Source: (IIASA 2012)

According to the economic growth models developed on the assumptions of the SSP2, the OECD model sees pronounced declines of growth rates from 2015 onwards in high income states of the EU along with the global development, whereas in medium income states, growth rates are expected to remain at a low but relatively constant level.

Figure 15: GDP/PPP according to PIK GDP-32 model (annual average growth rates in %)



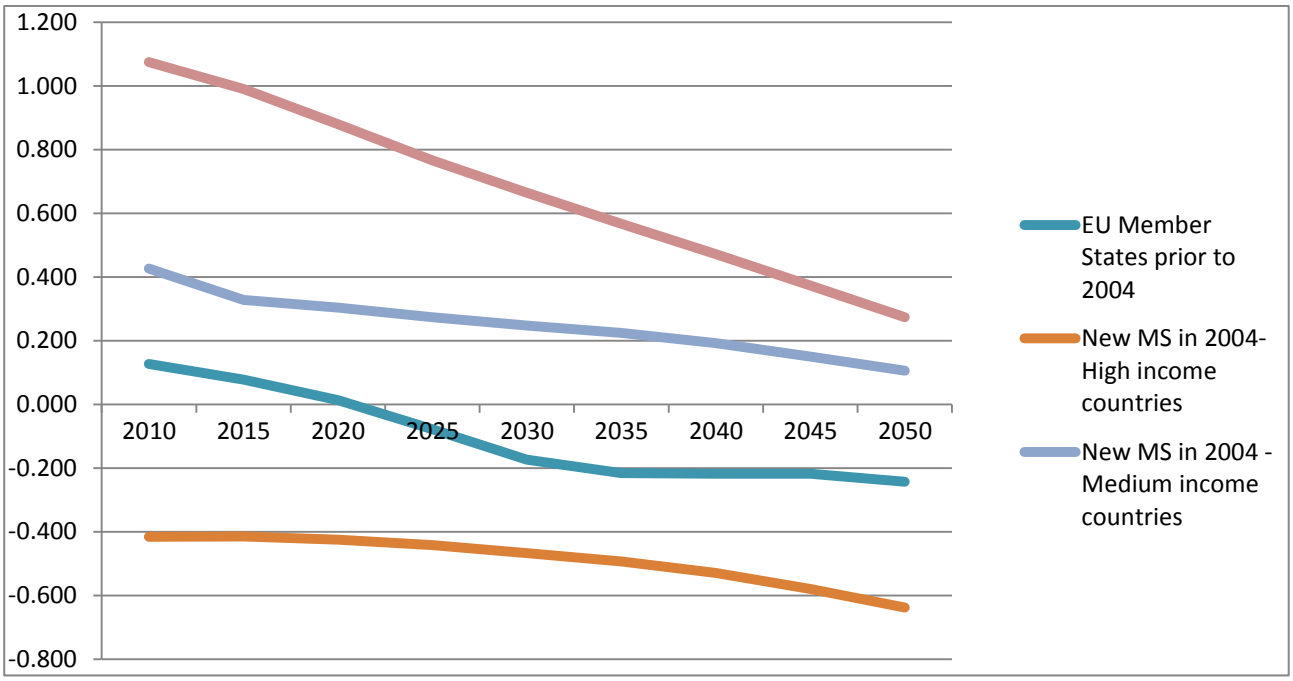
Source: (IIASA 2012)

The PIC GDP-32 model is even more pessimistic with regards to the economic growth perspectives for EU high income countries. Decreasing growth rates alongside with constant patterns of governance and national policies will have a negative effect both on possibility of public expenditure and investments by private actors, the effect for carbon leakage will continue at a lower pace.

IV.I.1 POPULATION:

Population growth rates are specified by framework scenarios implementing the SSPs, so those developing the SSP2, as for instance the IIASA-WIC model, indicate, for European high income countries, negative rates of population growth whereas other European member states will face declining growth rates.

Figure 16: Population growth according to IIASA WIC POP model (annual average growth rates in %)



Source: (IIASA 2012)

Although **fertility rates** cannot be influenced at the local level, policies creating attractive environments for urban life can change patterns of de- and re- urbanization, and attract specific social groups into the cities, preventing them from moving into the outskirts of the metropolitan areas.

In a similar manner, specific policies at local level will need to deal with incoming **climate migration**, that is, migration from developing countries will continue and eventually increase in the coming years.

IV.I.2 CLIMATE CHANGE

Although the SSPs can be combined with (almost all) RCPs, in the case of the SSP2, which is based essentially on a continuation of present day trends, the association with medium or high emission concentrations scenarios seems to be more reasonable considering also the underlying policy strategies. This implies that climate change impacts will be already tangible for urban areas in 2050, with an increasing number of heat waves and extreme weather events. Cities situated in the Mediterranean basin will furthermore need to take into account the possibilities of periods of drought or water scarcity (Lisbon, Barcelona, Turin and Milan and Zagreb). Albeit globally slightly increasing, in the tourism sector, the attractiveness of tourist destinations will change under hotter climates, especially in the Mediterranean area, with “urban tourism” being more and more important and with a shift of tourist seasons towards spring and fall.

Table 5: Relevant factors and corresponding trends for local post-carbon visions

RELEVANT FACTORS FOR LOCAL POST-CARBON VISIONS	TRENDS
Governance	
Balance of power	0

Trends towards privatisation / municipalisation	+
Demographics & social change	
Urbanization trends	+
Climate migration	+
Behavioural preferences	+
Consumption patterns of households,	+
Social values	+
Consumption/protection of common goods	0
National and international Economic context	
Income (in)equalities	+
Food prices (agriculture)	+
Tourism / tourism policies	0
Carbon leakage	++
Technological Change and Innovation	
Technology/innovation	+
Energy mix (external/ internal)	0
Resource efficiency	0
Closed cycles	0
Climate Change	
Weather events	++
Tourism	0/+

V REFERENCES

Alcamo, Joseph, Jacqueline Alder, Elena Bennett, Edward R. Carr, Danielle Deane, Gerald C. Nelson, and Teresa Ribeiro. 2005. "Four Scenarios." In *Ecosystems and Human Well-Being: Scenarios, Chapter 8*, by Millennium Ecosystem Assessment, 223 – 294. Washington D.C.: Island Press.

Alcamo, Joseph, Detlef van Vuuren, Claudia Ringler, Jacqueline Alder, E. M. Bennett, S. R. Carpenter, P. L. Pingali, E. M. Bennett, and M. B. Zurek. 2005. "Methodology for Developing the MA Scenarios." In *Ecosystem and Human Well-Being: Scenarios. Findings of the Scenarios Working Group.*, 145–72. Millennium Ecosystem Assessment. Washington, DC: Island Press,.

"AQUASTAT - FAO's Information System on Water and Agriculture." 2014. Accessed July 30. http://www.fao.org/nr/water/aquastat/main/index.stm.

Bennett, Elena, and Steve Cork. 2005. "Scenarios for Ecosystem Services: Rationale and Overview." *Ecosystems and Human Well-Being*, 119.

Capros, Pantelis, Leonidas Paroussos, Panagiotis Fragkos, Stella Tsani, Baptiste Boitier, Fabian Wagner, Sebastian Busch, Gustav Resch, Markus Blesl, and Johannes Bollen. 2014. "Description of Models and Scenarios Used to Assess European Decarbonisation Pathways." *Energy Strategy Reviews* 2 (3-4): 220–30. doi:10.1016/j.esr.2013.12.008.

Carlsson-Kanyama, Annika, Karl Henrik Dreborg, H.C. Moll, and Dario Padovan. 2008. "Participative Backcasting: A Tool for Involving Stakeholders in Local Sustainability Planning." *Futures* 40 (1): 34–46. doi:10.1016/j.futures.2007.06.001.

Carter, Timothy R., EMILIO L. La Rovere, R. N. Jones, R. Leemans, L. O. Mearns, N. Nakicenovic, A. B. Pittock, S. M. Semenov, and J. Skea. 2001. "Developing and Applying Scenarios." *Climate Change*, 145–90.

"CESR - SCENES PROJECT - Impact Analysis." 2014. Accessed August 6. http://www.1stcellmedia.de/customer/uni/cms/index.php?option=com_content&task=view&id=24&Itemid=84.

"CESR - SCENES PROJECT - Results." 2014. Accessed August 6. http://www.1stcellmedia.de/customer/uni/cms/index.php?option=com_wrapper&Itemid=139.

Curry, Andrew, and Anthony Hodgson. 2008. "Seeing in Multiple Horizons: Connecting Futures to Strategy." *Journal of Futures Studies* 13 (1): 1–20.

De Koning, Arjan, Gjalt Huppes, and Sebastiaan Deetman. 2014. *Scenarios for 2050 for a 2-Degrees World. Using a Four Regions Trade Linked IO-Model with High Sector Detail.* Leiden (NL): Institute of Environmental Sciences (CML) Leiden University. http://cecilia2050.eu/system/files/CECILIA2050%20D3-1b_2050-scenarios.pdf.

Ebi, Kristie L., Stephane Hallegatte, Tom Kram, Nigel W. Arnell, Timothy R. Carter, Jae Edmonds, Elmar Kriegler, Ritu Mathur, Brian C. O'Neill, and Keywan Riahi. 2013. "A New Scenario Framework for Climate Change Research: Background, Process, and Future Directions." *Climatic Change*, 1–10.

EEA. 2009. *Looking Back on Looking Forward: A Review of Evaluative Scenario Literature*. EEA Technical report 3/2009. Copenhagen: European Environment Agency (EEA). http://www.eea.europa.eu/publications/looking-back-on-looking-forward-a-review-of-evaluative-scenario-literature/at_download/file.

EFP. 2001. "European Communities, Foresight for Regional Development Network: A Practical Guide to Regional Foresight." http://www.foresight-platform.eu/community/foresightguide/what-is-foresight/.

Flagship Consortium. 2014. "Economic, Social and Environmental Challenges and Their Feedback into Integrated Scenarios Building. Flagship 2nd Workshop, Background Document."

GEA. 2012. *Global Energy Assessment - Toward a Sustainable Future*. Cambridge University Press, Cambridge, UK and New York, NY, USA and the International Institute for Applied Systems Analysis, Laxenburg, Austria. www.globalenergyassessment.org.

Grübler, Arnulf, Brian O'Neill, Keywan Riahi, Vadim Chirkov, Anne Goujon, Peter Kolp, Isolde Prommer, Sergei Scherbov, and Erik Slentoe. 2007. "Regional, National, and Spatially Explicit Scenarios of Demographic and Economic Change Based on SRES." *Technological Forecasting and Social Change* 74 (7): 980–1029.

IIASA. 2012. "SSP Database." https://secure.iiasa.ac.at/web-apps/ene/SspDb/dsd?Action=htmlpage&page=about.

———. 2014. "Climate Change & Socioeconomic Development." *Climate Change & Socioeconomic Development*. http://www.iiasa.ac.at/web/home/resources/publications/IIASAMagazineOptions/ClimateChange.en.html.

———. *Supplementary Note for the SSP Data Sets*. IIASA. https://secure.iiasa.ac.at/web-apps/ene/SspDb/static/download/ssp_suplementary%20text.pdf.

Kram, Tom, and Elke Stehfest. 2012. *The IMAGE Model Suite Used for the OECD Environmental Outlook to 2050*. PBL Note PBL publication number 500113002. The Hague: PBL Netherlands Environmental Assessment Agency. http://www.pbl.nl/sites/default/files/cms/publicaties/pbl-2012-the-image-model-suite-used-for-oecd-environmental-outlook-2050.pdf.

Krey, Volker, and Omar Masera. 2014. *Annex II: Metrics and Methodology*. IPCC Working Group III – Mitigation of Climate Change, AR5. Geneva, Switzerland: Intergovernmental Panel for Climate Change (IPCC). http://report.mitigation2014.org/drafts/final-draft-fgd/ipcc_wg3_ar5_final-draft_fgd_annex-ii.pdf.

Kriegler, Elmar, Jae Edmonds, Stéphane Hallegatte, Kristie L. Ebi, Tom Kram, Keywan Riahi, Harald Winkler, and Detlef P. van Vuuren. 2014. "A New Scenario Framework for Climate Change Research: The Concept of Shared Climate Policy Assumptions." *Climatic Change* 122 (3): 401–14. doi:10.1007/s10584-013-0971-5.

Kriegler, Elmar, Jae Edmonds, Stéphane Hallegatte, Kristie L. Ebi, Tom Kram, Keywan Riahi, Harald Winkler, and Detlef P. van Vuuren. 2014. "A New Scenario Framework for Climate Change Research: The Concept of Shared Climate Policy Assumptions." *Climatic Change* 122 (3): 401–14. doi:10.1007/s10584-013-0971-5.

Kriegler, Elmar, Brian C. O'Neill, Stephane Hallegatte, Tom Kram, Robert J. Lempert, Richard H. Moss, and Thomas Wilbanks. 2012. "The Need for and Use of Socio-Economic Scenarios for Climate Change Analysis: A New Approach Based on Shared Socio-Economic Pathways." *Global Environmental Change* 22 (4): 807–22. doi:10.1016/j.gloenvcha.2012.05.005.

Kriegler, Elmar, Keywan Riahi, Nico Bauer, Valeria Jana Schwanitz, Nils Petermann, Valentina Bosetti, Adriana Marcucci, et al. 2014. "Making or Breaking Climate Targets: The AMPERE Study on Staged Accession Scenarios for Climate Policy." *Technological Forecasting and Social Change*, March. doi:10.1016/j.techfore.2013.09.021.

Kriegler, Elmar, Keywan Riahi, Nils Petermann, Valentina Bosetti, Pantelis Capros, Detlef van Vuuren, Patrick Criqui, et al. 2014. *Assessing Pathways toward Ambitious Climate Targets at the Global and European Levels. A Synthesis of Results from the AMPERE Project*.

Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-Being: Scenarios. Findings of the Scenarios Working Group (Millennium Ecosystem Assessment Series, Volume 2)*. Washington D.C.: Island Press.

Moss, Richard H., Jae A. Edmonds, Kathy A. Hibbard, Martin R. Manning, Steven K. Rose, Detlef P. Van Vuuren, Timothy R. Carter, Seita Emori, Mikiko Kainuma, and Tom Kram. 2010. "The next Generation of Scenarios for Climate Change Research and Assessment." *Nature* 463 (7282): 747–56.

Nakićenović, N., J. Alcamo, G. Davis, B. De Vries, J. Fenhann, S. Gaffin, K. Gregory, A. Gr\übler, T. Y. Jung, and T. Kram. 2000. *IPCC Special Report on Emissions Scenarios (SRES)*. Cambridge: Cambridge University Press. http://www.ipcc.ch/ipccreports/sres/emission/index.php?idp=0.

Novotny, Vladimir. 2012. “Water and Energy Link in the Cities of the Future–achieving Net Zero Carbon and Pollution Emissions Footprint.” In *Water and Energy Interactions in Water Reuse*, edited by V. Lazarova, K. H. Choo, and P. Cornel, 37–59. London: IWA Publishing.

O’Neill, Brian C., Elmar Kriegler, Keywan Riahi, Kristie L. Ebi, Stephane Hallegatte, Timothy R. Carter, Ritu Mathur, and Detlef P. van Vuuren. 2013. “A New Scenario Framework for Climate Change Research: The Concept of Shared Socioeconomic Pathways.” *Climatic Change*, 1–14.

O’Neill, Brian, Timothy R. Carter, Kristie L. Ebi, Jae Edmonds, Stéphane Hallegatte, Linda Mearns, Keywan Riahi, et al. 2012. *Workshop on The Nature and Use of New Socioeconomic Pathways for Climate Change Research*. Meeting Report, Final Version. National Center for Atmospheric Research (NCAR), Boulder, CO. http://www.isp.ucar.edu/socio- economic-pathways.

OECD. 2012. *OECD Environmental Outlook to 2050 : The Consequences of Inaction*. Paris: Organisation for Economic Co-operation and Development (OECD).

Petersen, Morten Steen, Riccardo Enei, Hansen, Efrain Larrea, Oriol Obisco, Carlo Sessa, Paul M. Timms, and Andreu Ulied. 2009. *TRANSvisions. Report on Transport Scenarios with a 20 and 40 Year Horizon.* Kopenhagen: European Commission DG TREN. http://ec.europe.eu/transport/strategies/studies/strategies_en.htm.

Raskin, Paul D. 2005. “Global Scenarios: Background Review for the Millennium Ecosystem Assessment.” *Ecosystems* 8 (2): 133–42. doi:10.1007/s10021-004-0074-2.

Riahi, Keywan, Frank Dentener, Dolf Gielen, Arnulf Grubler, Jessica Jewell, Zbigniew Klimont, Volker Krey, et al. 2012. “Chapter 17 - Energy Pathways for Sustainable Development.” In *Global Energy Assessment - Toward a Sustainable Future*, 1203–1306. Cambridge University Press, Cambridge, UK and New York, NY, USA and the International Institute for Applied Systems Analysis, Laxenburg, Austria. www.globalenergyassessment.org.

Robinson, John B. 1982. “Energy Backcasting A Proposed Method of Policy Analysis.” *Energy Policy* 10 (4): 337–44.

———. 1990. “Futures under Glass: A Recipe for People Who Hate to Predict.” *Futures* 22 (8): 820–42.

The World Bank. 2012. *A Primer on Energy Efficiency for Municipal Water and Wastewater Utilities*. Technical Report 001.12. Washington D.C.: Energy Sector Management Assistance Program, The World Bank.

Theis, Jacques, and Eric Vidalenc. 2013. *Repenser Les Villes Dans La Société Post-Carbone*. Paris, France: Commissariat général au développement durable. http://www.developpement-durable.gouv.fr/IMG/pdf/VPC2013_web2_1_.pdf.

Theys, Jacques, and Eric Vidalenc. 2013. “Vers Des Villes Postcarbone. Six Scenarios Contrastes.” *Futuribles* 392: 5–25.

UN-DESA. 2012. *World Urbanization Prospects. The 2011 Revision Highlights*. Washington D.C.: United Nations Secretariat, Department of Economic and Social Affairs (UN-DESA). http://esa.un.org/unpd/wup/pdf/WUP2011_Highlights.pdf.

UNESCO - WWAP. 2014. *The United Nations World Water Development Report 2014: Water and Energy.* Paris: UNESCO WWAP (United Nations World Water Assessment Programme).

United Nations Environment Programme. 2008. “What Is a Scenario?” *IEA Training Manual - Module 6*. http://www.unep.org/ieacp/iea/training/manual/module6/1245.aspx.

United Nations Human Settlements Programme. 2012. *State of the World’s Cities, 2012/2013: Prosperity of Cities*. State of the World’s Cities. New York: UN-HABITAT. http://www.unhabitat.org/pmss/getElectronicVersion.aspx?nr=3387&alt=1.

Van den Berg, Caroline, and Alexander Danilenko. 2010. *The IBNET Water Supply and Sanitation Performance Blue Book: The International Benchmarking Network for Water and Sanitation Utilities Databook*. The World Bank. http://elibrary.worldbank.org/doi/book/10.1596/978-0-8213-8582-1.

Van Vuuren, Detlef P., Elmar Kriegler, Brian C. O'Neill, Kristie L. Ebi, Keywan Riahi, Timothy R. Carter, Jae Edmonds, et al. 2014. "A New Scenario Framework for Climate Change Research: Scenario Matrix Architecture." *Climatic Change* 122 (3): 373–86. doi:10.1007/s10584-013-0906-1.

Van Vuuren, Detlef P., Elmar Kriegler, Brian C. O'Neill, Kristie L. Ebi, Keywan Riahi, Timothy R. Carter, Jae Edmonds, Stephane Hallegatte, Tom Kram, and Ritu Mathur. 2013. "A New Scenario Framework for Climate Change Research: Scenario Matrix Architecture." *Climatic Change*, 1–14.

Van Vuuren, Detlef P., Keywan Riahi, Richard Moss, Jae Edmonds, Allison Thomson, Nebojsa Nakicenovic, Tom Kram, et al. 2012. "A Proposal for a New Scenario Framework to Support Research and Assessment in Different Climate Research Communities." *Global Environmental Change* 22 (1): 21–35. doi:10.1016/j.gloenvcha.2011.08.002.

WBCSD. 1997. *Exploring Sustainable Development Global Scenarios 2000- 2050*. London: WBCSD Global Scenarios Project.