POCACITO

european post-carbon cities of tomorrow

DI.I COMMON APPROACH FRAMEWORK DOCUMENT

FINAL VERSION

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LIST OF ABBREVIATIONS

CA	Common Approach
CB	Consumption Based
CSW1	Common Source Work Package 1
DOW	Description of Work
DPSC	Direct Plus Supply Chain
EEIO	Environmentally Extended Input-Output Model
EU	European Union
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GPC	Global Protocol for Community
IPCC	Intergovernmental Panel on Climate Change
KO	Kick Off (Meeting)
RCP	Representative Concentration Pathway
SES	Social-Ecological System
WP	Work Package

I MOTIVATION

The POCACITO project aims to facilitate the transition of EU cities to a sustainable or "post-carbon" economic and societal model in a global context. This outlook serves to assess the long-term trends and tensions in EU cities that impact urban development and to explore innovative approaches for achieving sustainable post-carbon cities in the EU, thereby contributing to the Roadmap for moving to a low-carbon economy in 2050 and supporting the EU Innovation Union flagship initiative. The objective of the project will be achieved by:

- Assembling an inventory of current initiatives and best practices that provides an overview of potential measures and successful approaches to a post-carbon transition.
- Producing an initial assessment of the current situation in case study cities as an input into the city-level scenario development.
- Identifying win-win situations at the city level regarding greenhouse gas (GHG) emissions reductions and tackling other environmental problems, such as air pollution and climate change adaptation. The project will inform partner cities in the EU and in emerging economies about best practices and potential policy transfers through a dedicated 'Marketplace of Ideas' comprising study tours and online learning opportunities. This will facilitate mutual learning, vision exchanges and the sharing of experiences among EU cities and in the international community.
- Developing together with stakeholders a set of qualitative socio-economic scenarios according to the post-carbon vision of each case study city.
- Conducting a quantitative gap analysis to measure the distance between the scenarios, business-as-usual development, and the post-carbon vision of each city. The result of the gap analysis will inform stakeholders about additional measures that need to be taken in order to reach the post-carbon vision for the city.
- Assessing the socio-economic impacts of the scenarios and measures through an iterative approach and adjusting the choice of measures according to the results of the assessment.

While a diversity of tasks are conducted throughout the project's work packages, all use a set of shared key concepts, terminologies and assumptions. These are clarified in the Common Approach Framework Document (hereby Common Approach) to ensure consistency throughout the project – a harmonised approach will enhance the comparability, scope and scale of results. This is particularly important since the project team brings together scholars from different disciplines. The Common Approach thereby serves as a basis and reference for all research activities. Of particular importance are the concepts of foresight, post-carbon cities and urban transitions. After establishing an understanding of these concepts, the Common Approach presents a framework for the implementation of project activities.

The Common Approach builds on discussions that took place during an internal workshop at the project kick-off meeting as well as subsequent web conferences, collaborations among partners and an in-depth, multi-disciplinary literature review of relevant concepts and trends concerning urban development. As a living guidance document, the Common Approach is meant to facilitate the ongoing exchange of ideas and knowledge between project partners and stakeholders. The document will be refined to reflect updates in the scientific literature, internal discussions, and methodologies throughout the duration of the project, thus providing the project with both structure and flexibility.

The document is organised as follows. Section II provides an overview of key concepts derived from an extensive literature review. Section III details the main project activities and how they relate and contribute to the theoretical concepts discussed in the previous section. Section IV concludes by discussing the open issues as well as the necessary steps to provide further clarification.

II KEY CONCEPTS

The concepts of foresight, post-carbon cities, and systems thinking are essential to the POCACITO project. The information presented in the following section is used to develop the methodologies for project activities.

II.I FORESIGHT

Foresight, 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 of governance and technology, developing foresight exercises and building scenarios is of crucial importance for strategic planning. Key actors at the city level can support transition processes by making better decisions on long-term investments in infrastructure 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.

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 by examining the factors and trends that form future developments, providing insight into 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., city-level indicators). Global scenarios (see Section III.III.III) will be used as the background conditions for the city-level foresight activities.

More specifically, the objectives of the POCACITO foresight activities are as follows (EFP 2001):

- **To inform policy-making** so that city-level actors are aware of the longer term implications of current policy decisions. Foresight activities will help inform stakeholders of possible future developments and how these may interact with the policy decisions made today. Foresight exercises also seek to raise awareness about future risks and opportunities.
- **To build networks** that bring together diverse groups of stakeholders involved in shaping the future of a city. By establishing these networks, POCACITO aims to encourage mutual understanding, to build trust, and to develop partnerships among groups that may otherwise have limited opportunities to interact with one another. A collective understanding of the challenges and opportunities facing a city will enhance collaboration and cooperation. A diversity of perspectives also increases the innovativeness and comprehensiveness of solutions.

- **To develop capabilities** at the city level to conduct foresight activities after the completion of the POCACITO project and to integrate them into their planning processes as well as local culture.

- **To build strategic visions** (which can build upon existing city initiatives) about the future of cities and create a shared sense of commitment to work towards these visions among foresight participants.

However, the project recognises that "even well-crafted scenarios can fail to have their intended policy impact if they present irrelevant information, lack support from relevant actors, are poorly embedded into relevant organisations or ignore key institutional context conditions" (EEA 2009). A targeted selection of stakeholders, relying, inter alia, on stakeholder mapping exercises, supports POCACITO's efforts to provide a representative image of stakeholders' views and preferences. This should reduce difficulties arising from partial or biased stakeholder participation, which has in the past often led to scenarios including topical issues of concern to only single groups of stakeholders.

II.I.I PARTICIPATORY SCENARIO DEVELOPMENT

Essential to the concept of foresight is the participative dimension, which distinguishes it from other planning activities. This dimension involves "a number of different groups of actors concerned with issues at the stake"(EFP 2001). POCACITO therefore uses *participatory scenario development* to bring together a diverse group of local-level stakeholders to develop local post-carbon visions and quantify their respective environmental, social and economic impacts (see Section III.II). Participatory scenario development is a "process that involves the participation of stakeholders to explore the future in a creative and policy-relevant way" (World Bank 2010). This process is used to identify the effects of alternative responses to emerging challenges, to determine how different groups of stakeholders view the range of possible policy and management options available to them, and to identify the public policies or investment support needed to facilitate effective future actions (Bizikova, Boardley, and Mead 2010). Participatory scenario development has the potential to make scenarios more relevant to stakeholder needs and priorities, extend the range of scenarios developed, develop more detailed and precise scenarios through the integration of local and scientific knowledge, and move beyond scenario development to facilitate adaptation to future change (Reed et al. 2013). The process has great potential to empower stakeholders and lead to more consistent and robust scenarios that can help people prepare more effectively for future change (Reed et al. 2013).

By integrating scientific and local knowledge, the participatory scenario development applied in POCACITO holds the potential to enhance the relevance to stakeholders and improve the preciseness of scenarios. Furthermore, foresight activities are seen as an iterative and learning process – local scenarios and visions will be revised throughout the series of workshops using feedback from stakeholders.

II.I.II LIVING LAB ENVIRONMENT

The case study workshops create a *living lab environment* that involves a variety of stakeholders during the vision and scenario building process. The living lab approach aims to enhance innovation by bringing together a diversity of views, constraints, and knowledge. Together, participants will explore and co-develop possible future scenarios of their city. By using the sensitivity model (Section III.II.II) to quantitatively model the future impacts of proposed visions and scenarios, the living labs also serve as platforms for experimentation where the stakeholders can evaluate and revise city visions based on locally defined criteria. Moreover, engagement with local stakeholders will develop a momentum for communities, city officials, and practitioners who will be able to implement the innovative findings of the project.

Box 1: What do we mean by stakeholders?

A stakeholder is any individual, organisation, or representative of a sector or community who has a 'stake' in the outcome of a given decision or process (Stakeholder Forum for a Sustainable Future). At the city level, this includes a wide range and diversity of individuals, groups, and institutions. The challenge for the POCACITO project is to identify relevant stakeholders for project activities, which include, but are not limited to:

- Elected representatives
- City planners/architects
- Educational and cultural institutions (e.g., universities, campus/industrial technology parks)
- Financial specialists
- Banks
- Urban economics, sociology and demographics specialists
- Utilities providing cities with water and waste infrastructures, environmental services, energy
- Public transport providers
- Main local enterprises and industries which act as energy consumers and jobs suppliers
- ICT companies
- Construction companies
- System solutions providers (e.g., Siemens, ABB)
- Local energy agencies
- Civil society representatives
- Other public institutions of relevance at the local level (e.g., regional or national authorities)
- the general public

Case study workshops will involve a broad range of these stakeholders totalling approximately 15-20 per workshop (although more can attend the presentation of the initial assessment results (CSW1) if deemed necessary). Additional stakeholders will be targeted for other WP activities. During the Kick Off meeting, a list of stakeholders for each WP was identified and their contact information is being compiled by Energy Cities and is available on the internal area of the project website. The dissemination strategy (D8.1) will provide further details about the involvement of stakeholders in project activities.

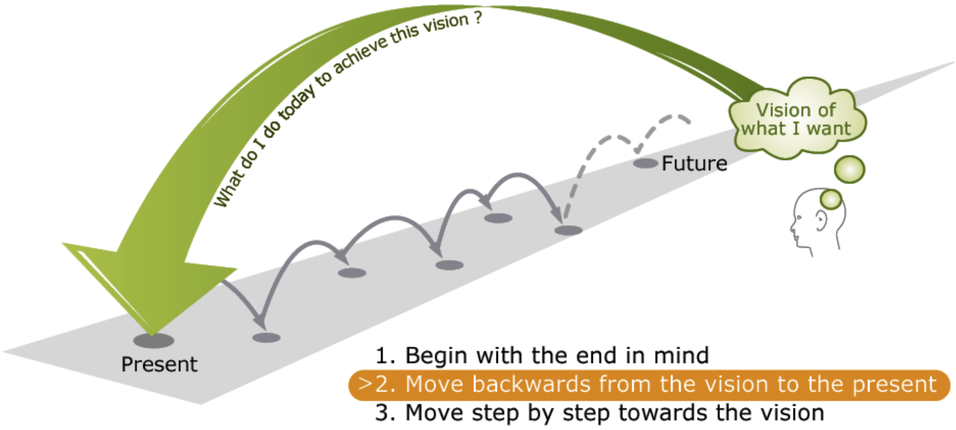
II.I.III BACKCASTING

POCACITO applies the planning methodology of backcasting. As an alternative to traditional forecasting, which merely extrapolates present trends into the future (Robinson 2003; Robinson 1990), backcasting allows participants to envision future desired conditions and then to define the steps needed to attain those conditions (Holmberg and Robèrt 2000). Backcasting is a particularly useful method when (Dreborg 1996):

- The problem to be studied is complex.
- There is a need for major change.
- Dominant trends are part of the problem.
- The problem to a great extent is a matter of externalities.
- The scope is wide enough and the time horizon long enough to leave considerable room for deliberate choice.

As all of these features are true for the complex nature of urban systems (Section II.II), backcasting is deemed the appropriate tool to conduct case study workshops as it can “increase the likelihood of handling the ecologically complex issues in a systematic and coordinated way” (Holmberg and Robèrt 2000).

Figure 1: Visualising backcasting



Source: The Natural Step 2014

Visioning, or generating a picture of a desirable future (or futures), will allow stakeholders to create a shared set of expectations of the future(s) for their city and to articulate a potential pathway(s) of urban development. More broadly, shared expectations or ‘guiding visions’ are recognised as playing an important role in shaping both the speed and direction of technological and social change. Unlike the ‘blind’ evolution of biological processes, the quasi-evolutionary processes which underpin complex systems include an element of premeditation and choice. We actively shape the future through the choices and decisions we make in the present. Guiding visions then play a generative or ‘performative’ role: providing legitimacy, mobilising investment, promoting network formation, and reducing risk through aligning priorities and activities (Eames et al. 2006; Lente 1993; Dierkes, Hoffman, and Marz 1996).

II.II CITIES AS SOCIAL-ECOLOGICAL SYSTEMS

Cities are complex, adaptive, social-ecological systems (SES) (Levin and Harvey 1999; Berkes, Colding, and Folke 2003; Gunderson and Holling 2001; Norberg and Cumming 2008; Evans 2008) "characterised by a particular human settlement pattern that associates with its functional or administrative region, a critical mass and density of people, man-made structures and activities" (UNEP 2011). Responsible for the majority of the world's GHG emissions (Hoornweg and Freire 2013), cities are increasingly becoming the focal point of climate change mitigation strategies. Nevertheless, the inherent complexity and feedback mechanisms of urban systems complicate mitigation efforts as they may potentially result in unintended or undesirable consequences on other environmental, social and economic aspects of the city. Further complicating the situation is the fact that cities, as open dynamic systems, respond to disturbances in their external environments in addition to internal environments (Evans 2008). This means that cities evolve in response to global, exogenous factors that are out of their realm of influence.

II.II.I RESILIENCE, ADAPTIVE CAPACITY AND TRANSFORMABILITY

The "capacity of an urban system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks" is its resilience (Walker et al. 2004). Resilience is comprised of the following aspects (taken directly from Walker et al. 2004, p. 2-3):

- **Latitude**: the maximum amount a system can be changed before losing its ability to recover (before crossing a threshold which, if breached, makes recovery difficult or impossible).
- **Resistance**: the ease or difficulty of changing the system; how "resistant" it is to being changed.
- **Precariousness**: how close the current state of the system is to a limit or "threshold."
- **Panarchy**: because of cross-scale interactions, the resilience of a system at a particular focal scale will depend on the influences from states and dynamics at scales above and below. For example, external oppressive politics, invasions, market shifts, or global climate change can trigger local surprises and regime shifts.

The adaptive capacity[1] of urban systems is the ability of stakeholders – i.e., human actors – to improve its resilience (Berkes, Folke, and Colding 2000; Folke et al. 2004; Gallopín 2006; Lebel et al. 2006; Olsson et al. 2006) to fluctuating environmental and socio-economic pressures, such as climate change, long-term changes in urban resident demographics, city and rural migration patterns, and health concerns. Walker et al. (2004) note that:

[1] Adaptability is measured by the "ability to either control the trajectory of the system (change precariousness), change the topology of the stability landscape (latitude and resistance), or change the processes in response to dynamics at other scales (panarchy response)" (Walker et al. 2004).

"[THE ACTIONS OF INDIVIDUALS AND GROUPS MANAGING THE SYSTEM] INFLUENCE RESILIENCE, EITHER INTENTIONALLY OR UNINTENTIONALLY. THEIR COLLECTIVE CAPACITY TO MANAGE RESILIENCE, INTENTIONALLY, DETERMINES WHETHER THEY CAN SUCCESSFULLY AVOID CROSSING INTO AN UNDESIRABLE SYSTEM REGIME, OR SUCCEED IN CROSSING BACK INTO A DESIRABLE ONE."

When ecological, social, or economic structures make the existing system unsustainable, it may be necessary to fundamentally change the nature of the system – to transform it[2]. Considering the urgency of global climate change and other environmental, social and economic pressures, it is presumed that the current urban system is close to crossing several thresholds of sustainability and that a new system – the post-carbon city – is necessary to prevent the movement into an undesirable state from which it is difficult, if not impossible, to recover.

II.II.II POST-CARBON CITIES

WITHIN THE POCACITO FRAMEWORK, THE CONCEPT OF **"POST-CARBON CITIES"** SIGNIFIES A RUPTURE IN THE CARBON-DEPENDENT URBAN SYSTEM, WHICH HAS LEAD TO HIGH LEVELS OF ANTHROPOGENIC GREENHOUSE GASES, AND THE ESTABLISHMENT OF NEW TYPES OF CITIES THAT ARE LOW-CARBON AS WELL AS ENVIRONMENTALLY, SOCIALLY AND ECONOMICALLY SUSTAINABLE. THE TERM POST-CARBON EMPHASISES THE PROCESS OF TRANSFORMATION, A SHIFT IN PARADIGM, WHICH IS NECESSARY TO RESPOND TO THE MULTIPLE CHALLENGES OF CLIMATE CHANGE, ECOSYSTEM DEGRADATION, SOCIAL EQUITY AND ECONOMIC PRESSURES. THROUGH THEIR ADAPTIVE CAPACITY, POST-CARBON CITIES USE THE THREAT OF CLIMATE CHANGE "AS AN OPPORTUNITY TO REDUCE VULNERABILITY AS THEY RESTRUCTURE HUMAN–ECOLOGICAL AND HUMAN–HUMAN RELATIONSHIPS TOWARD ECOSYSTEM HEALTH AND A CLEAN ENERGY ECONOMY"(EVANS 2008, P.3; BASED ON ADGER 2006; NEIL ADGER, ARNELL, AND TOMPKINS 2005).

Although there have been many attempts to create a "comprehensive and transferable model of sustainable urban development" (Rapoport 2014), e.g., eco-cities and smart-cities (see Box 2), there is still no consensus about what these concepts mean and the criteria necessary for classification. Furthermore, despite examples of successful sustainable urban projects, there is a substantial "gap between [the] aspirations and achievement" of initiatives (Rapoport 2014; Joss 2011; Barton 2000). The precedence of economic considerations is often cited as a reason for the limited success and

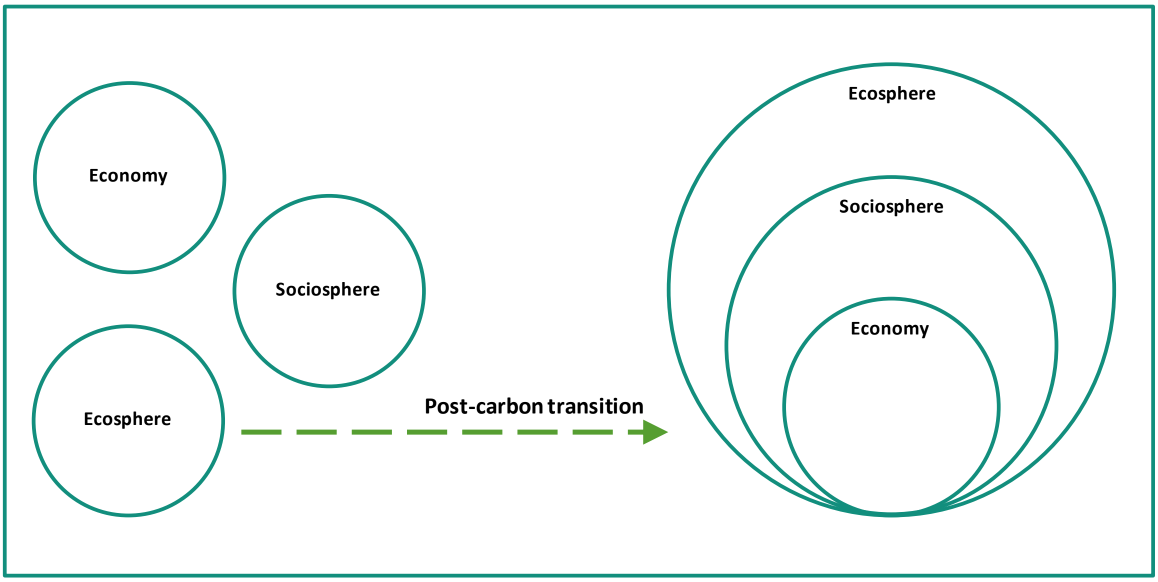
[2] Walker et al. (2004) explain that "At times societies or groups may find themselves trapped in an undesirable basin [equilibrium state] that is becoming so wide, and so deep, that movement to a new basin or sufficient reconfiguration of the existing basin becomes extremely difficult. At some point, it may prove necessary to configure an entirely new stability landscape—one defined by new state variables, or the old state variables supplemented by new ones."

impact of projects (Rapoport 2014) as well as the more recent emphasis on large, top-down flagship sustainable urban development projects instead of the bottom-up initiatives that characterised many of the early developments.

The challenges facing the implementation of sustainable cities highlight the need for a new approach, a shift in mindset, which recognises that there may be significant tradeoffs among – and within – environmental, social and economic goals, making the assessment and decision-making process more complex. Research that focuses on the experience and decision making of stakeholders when confronted with these complexities would reflect the realities facing local actors and enhance the transferability of solutions (Roelofs 2000).

POCACITO adds to the discourse on sustainable cities by integrating a component that emphasises urban system transitions and creates a framework for stakeholder participation in city-level planning and decision making processes. The main characteristics of eco-cities and smart cities are also important aspects of post-carbon cities, although the POCACITO consortium considers it counterproductive to provide a definition of post-carbon cities that is too narrow or to prescribe a list of necessary characteristics – due to the diversity of cities and local circumstances, features of post-carbon cities will vary according to each city. Although the lack of clear standards may undermine the value of the concept, it also allows for "flexibility… in order to deal with the variety of context[s] in which the model will be applied" (Rapoport 2014).

Figure 2: The Ecosphere, Sociosphere and Economy as nested systems



To provide structure for the analysis of cities, a set of post-carbon city key performance indicators will be developed (Section III.II), which will integrate relevant aspects of urban sustainability. As social-ecological systems cannot be fully understood by examining individual components, POCACITO moves away from analysing the three dimensions of sustainability as silos and towards a more comprehensive approach (Figure 2) that assesses the relationships among factors and feedback loops of the entire system. The project uses the systems thinking approach (see Section II.III) in order to analyse the dynamics of urban systems and to identify key features of post-carbon city transitions.

Box 2: Utopian visions of cities: eco-cities and smart-cities

ECO-CITIES

Much debate surrounds the term “eco-city” as the number and diversity of projects labelled as such has grown tremendously since the term was coined by Richard Register in 1987. Originally described as “an urban environmental system in which input (of resources) and output (of waste) are minimized” (Register 1987), there is still no one accepted definition or standard for an eco-city. Rather, the term is regarded as an “umbrella concept” or a collection of ideas of how to create more sustainable urban areas (Rapoport 2014; Jabareen 2006).

Nevertheless, there have been several attempts to define a set of normative criteria for eco-cities (Rapoport 2014). For instance, Kenworthy (2006) identifies ten eco-city dimensions, which emphasise a compact, mixed-use urban form; public transit and non-motorised modes of transportation; a natural environment that is intact and helps sustain the city’s food needs; the use of environmental technologies for resource and energy efficiency; public culture, community, equity, and good governance; economic performance and employment maximised by innovation, creativity and the uniqueness of the local environment, culture and history; a physical structure and urban design that is appropriate for the needs of inhabitants; visionary planning processes that integrate social, economic, environmental and cultural considerations as well as democratic, inclusive, and empowering decision making (refer to Kenworthy 2006 for an in depth discussion of the dimensions).

SMART-CITIES

“Smart cities” are characterised as cities that use innovative solutions mainly linked to the investment in technology to address burgeoning municipal problems. The term “smart” is usually a shorthand reference to public or private investment (in this case at a municipal level) in information communications technology (ICT), or “smart” industries and other industries implying ICT in their production processes (Rudolf 2007). Investment can take on many shapes to address a wide range of issues facing cities including, but not limited to the following: increased populations, polarised economic growth, increased GHG emissions, and decreased budgets (Ogorkiewicz and Falconer 2013).

In light of these emerging issues, cities have been called on to act “smarter” in addressing these problems. Examples of smart city investments include retrofitting of building stock, smart energy grids and broadband access, electric vehicle charging infrastructure, installation of heat networks, onsite renewable energy generation, and involvement in more general adaptation and mitigation (Ogorkiewicz and Falconer 2013).

It should be acknowledged that “smart” cities do not only imply technological investment or engagement in municipal spaces. Rather, the term can also imply innovation and the improvement of cities spaces in other “soft” industry areas. For example, the European Smart Cities model considers a “smart city” to be a city, which performs well in six distinct categories: smart economy, smart mobility, smart environment, smart people, smart living and smart governance (Rudolf 2007).

II.III SYSTEMS THINKING

In order to frame POCACITO's understanding of the urban system, we will first shed light on systems thinking in general and why it is important for the project. We will then define transition processes before we discuss how urban transitions can be managed.

II.III.I A THEORETICAL OVERVIEW

Systems thinking – or system dynamics – began to materialise as a professional field during the late 1950s and "provides a common foundation that can be applied wherever we want to understand and influence how things change through time" (Forrester 1991, p. 5). Acknowledging that it is dangerous to generalise about complex systems (Meadows 1999), Forrester (1991), the "inventor" of systems thinking, identifies two general characteristics about systems: 1) Inherent to most decisions are long-term and short-term trade-offs. However, these are not sufficiently considered in management and political decisions. And 2) Systems are highly resistant to policy changes. Forrester asks "have not mayors of cities also discovered most of their policies to have been without effect?" (Forrester 1991, p. 27). For POCACITO, where we aim at supporting the post-carbon transition of urban systems, these aspects are highly relevant.

Systems thinking is based on several assumptions or viewpoints. A system – in the case of POCACITO, the city – is seen as a unit that is made up of several units, which can only fulfil certain functions as a whole. Furthermore, systems are changing entities, not rigid structures. Therefore, when analysing systems, one needs to think in processes and not in certain states (this is particularly relevant for defining transition processes, see below). A system has a certain order (a structure), which is determined by its elements and their relations. In the case of a city, this means that a certain order (the political, juridical or economic system, as well as the physical structure of the city) is determined by the city's building blocks, which include both actors (e.g., utilities, network operators, transport companies, local government) as well as characteristics (e.g., physical architecture of a city, climate, geography, etc.) and the relationships among them. Furthermore, a system (the city) is composed of subsystems. It is therefore crucial to define the system borders (see Section III.III.I) – i.e., the inner and outer part of the system.

A description of the city (e.g., the inner system made up of the political and economic system, physical structure, etc.), and an inventory of where most of the GHG emissions stem from, as well as other social and economic problems (the subsystems), help identify what possible measures could lead to a post-carbon transition process. Here, the systemic thinking approach leaves enough leeway for describing and analysing the particularities of each case study city, while at the same time enabling researchers to recognise and analyse patterns (see Section III.III.IV). By looking for similarities, researchers can recognise city characteristics and elements of transition pathways.

II.III.II DEFINING THE TRANSITION PROCESS

The transition of cities in industrialised countries to become more sustainable through the three pillars – environment, society and economy – requires dramatic improvements in energy and water-use efficiency; alternative transportation modes such as walking, bicycling, and mass transit;

investments in green infrastructure; waste minimisation (reduced packaging and increased use of composting, waste-to-energy, and recycling); promotion of regional food systems; sustainable housing; as well as other measures in governance or education structures. Along with environmental concerns, policies and planning must also confront key socio-economic issues, such as aging populations, migration, health, poverty and exclusion of the urban poor.

> "A TRANSITION CAN BE DEFINED AS A GRADUAL, CONTINUOUS PROCESS OF CHANGE WHERE THE STRUCTURAL CHARACTER OF A SOCIETY (OR A COMPLEX SUB-SYSTEM OF SOCIETY) TRANSFORMS. TRANSITIONS ARE NOT UNIFORM, AND NOR IS THE TRANSITION PROCESS DETERMINISTIC: THERE ARE LARGE DIFFERENCES IN THE SCALE OF CHANGE AND THE PERIOD OVER WHICH IT OCCURS. TRANSITIONS INVOLVE A RANGE OF POSSIBLE DEVELOPMENT PATHS, WHOSE DIRECTION, SCALE AND SPEED GOVERNMENT POLICY CAN INFLUENCE, BUT NEVER ENTIRELY CONTROL" (ROTMANS ET AL 2001, P. 16).

Transitions are systemic changes with deep structural as well as societal components. Such changes are necessary if we want to solve contemporary environmental problems such as climate change, loss of biodiversity, and resource depletion (Geels 2011, p. 24). These transitions change the whole system starting from the micro-level (e.g., consumer behaviour) via the meso-level (e.g., cultural meaning and scientific knowledge, but also policies and markets) to the macro-level (e.g., infrastructure such as transport or agri-food systems). Consequently, transitions are "complex and long-term processes comprising multiple actors" (Geels 2011, p. 24).

William Bridges (2004) looks at transitions from a psychological point of view and states that transitions are the psychological process of adapting to change. He identifies three phases of transitions: 1) letting go of the past, 2) the neutral zone where the old has already ended but the new is not fully internalised yet and 3) the new beginning. Bridges points out that four P's are essential for the new beginning to happen: What is the **purpose** of the transition? What is the **picture** of the desired outcome? What is the **plan** to make the transition process happen? What **part** will each person play? Although this framework was created for the individual level in the context of organisational changes, it can also help to structure the transitions envisaged within POCACITO. The three phases can also be identified within cities and the four P's will help cities to structure their transition processes and include key stakeholders (citizens, businesses, etc).

Furthermore, transitions with regard to sustainability – the aim of POCACITO – have three characteristics that distinguish them from other transitions (Geels 2011, p. 25):

- Sustainability transitions are goal-oriented. However, since the goal (sustainability) is a collective good, there are hardly any incentives for private actors to engage in sustainability transitions.
- Sustainable solutions usually do not offer obvious user benefits (again: since sustainability is a collective good). Therefore, economic framework conditions need to be changed so that

innovations can replace existing systems[3]. This requires changes in policies beforehand to address politics and power struggles, which are likely to emerge since vested interests will probably try to resist these changes.

- The third characteristic is based on the assumption that it is not incumbent firms, but pioneers who develop innovations and thus help start or implement transitions. Moreover, incumbent firms will probably stick to the old regime. Therefore, innovation and innovative businesses are seen as a driver of transition.

Here, it is important to keep in mind what we have stated earlier: Cities should be understood as complex social-ecological systems and require a comprehensive transition process. Knowing the building-blocks, actors and interactions within a system allows for an active steering of the system towards post-carbon cities.

II.III.III MANAGING URBAN TRANSITIONS

Meadows (1999) identifies twelve leverage points (Box 3), i.e., places to intervene in a system if one wants to change it. These leverage points will help POCACITO structure potential urban transitions on a theoretical level.

Box 3: System leverage points[4]

12. Constants, parameters, numbers (such as subsidies, taxes, standards).
11. The sizes of buffers and other stabilizing stocks, relative to their flows.
10. The structure of material stocks and flows (such as transport networks, population age structures).
9. The lengths of delays, relative to the rate of system change.
8. The strength of negative feedback loops, relative to the impacts they are trying to correct against.
7. The gain around driving positive feedback loops.
6. The structure of information flows (who does and does not have access to what kinds of information).
5. The rules of the system (such as incentives, punishments, constraints).
4. The power to add, change, evolve, or self-organize system structure.
3. The goals of the system.
2. The mindset or paradigm out of which the system---its goals, structure, rules, delays, parameters---arises.
1. The power to transcend paradigms.

Source: taken directly from Meadows 1999, p. 3

On a more practical level, it is clear that a city itself is part of a larger system – at least the legal, economic, and political system under which it operates– and therefore only has a certain decision and management scope. For instance, often a city is not in the position to decide on taxes or to determine the electricity mix. However, it usually has leeway in questions of infrastructure, city design, land use

[3] Including innovations for products, processes, marketing, and organisations (European Union 2013).

[4] Listed in increasing order of effectiveness.

planning and public procurement. Since these policy fields are at the centre of the cities' spheres of influence, they are of major interest for POCACITO and should be mirrored with the leverage points identified by Meadows (1999, see above).

Although there is no agreement among researchers about how cities should be redesigned and restructured so that they can become more sustainable (there is also a lack of theories or approaches to prove or monitor the contribution of a particular city design, see Jabareen 2006, p. 38f), some aspects have been repeatedly discussed within the literature. These include.[5]

- **Compactness of a city**: The compactness of a city reflects how efficiently urban land is used. It can lead to minimisation of different transport ways (e.g., of energy, water, materials, products, and people) (Jabareen 2006, p. 39). Ultimately, good city compactness can lead to the reduction of GHG emissions.
- **Density**: Density is defined as the ratio of people or dwelling units to land area. As density increases, automobile ownership and travel decline (Jabareen 2006, p. 41). However, taking into account the social equity aspect of sustainability, cities can also become too dense. The question is therefore, which ratio is a good one from both environmental and social perspectives.
- **Mixed land use**: A mixed land use reduces the probability of using a car since multi-purpose trips can be achieved in proximity if residential, commercial, industrial, institutional, and leisure land uses are mixed (Jabareen 2006, p. 41).
- **Diversity**: Diversity includes mixed land use and a greater variety of housing types, building densities, household sizes, ages, cultures, and incomes (Jabareen 2006, p. 42).
- **Passive Solar Design**: The ecological design, together with a mixed land use, that enhances energy efficiency. Consequently, planning and policies should consider the built form of a city (airflow, view of sun and sky, exposed surface area); the street canyon (width to height ratio); the building design (heat gains and losses); urban materials and surface finish (influence absorption, heat storage and emissivity); vegetation and bodies of water (evaporation and cooling processes); and traffic (reduce air and noise pollution) (Jabareen 2006, p. 42).

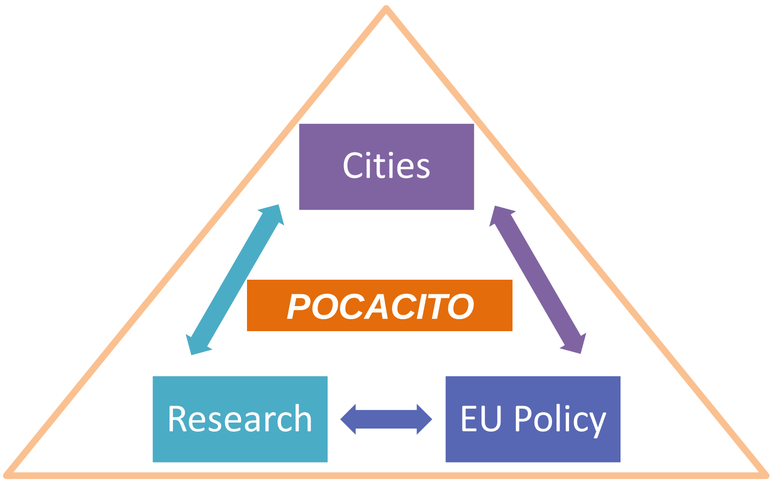
For POCACITO, both the leverage points identified by Meadows (1999) as well as particular elements of city design will be relevant to manage urban transitions.

[5] Refer to Box 2 for a discussion of eco-city and smart-city characteristics.

III PROJECT ACTIVITIES

The project consists of three layers – a research layer, urban layer and an EU policy layer (Figure 3) – which mutually support one another. At the nexus of these layers lie the POCACITO case study cities where local workshops and meetings will be held. Case studies will be assessed using indicators identified as appropriate for the environmental, social and economic dimensions of post-carbon cities. These indicators serve as guidelines and inputs for vision and scenario building rather than prescriptive criteria of post-carbon cities. Furthermore, the qualitative and quantitative analyses of the case studies are conducted under a specific framework. The assumptions the project makes regarding the spatial boundaries, temporal scope, and global scenarios, as well as the model used for quantitative analysis, are detailed below.

Figure 3: Three layers of POCACITO



III.I CASE STUDIES

POCACITO develops innovative, long-term outlooks for European post-carbon cities to address climate change adaptation and urban concerns by using a participatory city case study approach. Case study cities selected for the project include Barcelona, Copenhagen/Malmö, Istanbul, Lisbon, Litoměřice, Milan/Turin, Offenburg and Zagreb.

III.I.I ROLE

The project recognises that post-carbon city transitions should improve urban resilience to fluctuating endogenous and exogenous environmental and socio-economic pressures. The project activities aim to support post-carbon city transitions within the selection of case study cities and use these experiences to further transitions at the EU and global level. The role of case study activities within POCACITO are therefore to enhance *mutual learning*, or the open-ended exchange of knowledge on issues of common concern in order to improve coordination and decision making, both *within and among cities*.

III.I.II SELECTION

The case study cities selected for the project include Barcelona, Copenhagen/Malmö, Istanbul[6], Lisbon, Litoměřice, Milan/Turin, Offenburg and Zagreb. These cities were chosen due to their diversity and geographic locations. The characteristics of the case studies differ widely according to size, density, wealth, climate as well as governance and economic structures. Although this complicates the standardisation of the case study activities within the project, it also strengthens the project's ability to transfer lessons learned and best practices to a wider range of EU and global cities. Each case study will analyse economic, social and ecological flows, but will have different thematic emphases depending on the main challenges and pressures.

The selection of case-studies was developed according to a matrix crossing the following criteria:

- Economic, social and ecological flows under the following themes: water, waste, energy, transport, food, green infrastructure and adaptation to climate change.
- Territorial (cross border, mountain areas, inland, central and coastal regions) and geographical (Northern, Southern, East and Central Europe, and Nordic Countries) location according to the ESPON regional typology database 2013.

					City Challenges							
City / Region	Region typology	Location	Main aspects	Population in municipality (and region)	Water	Waste	Energy	Air	Mobility	Food	Green infra-structure	Climate adap-tation
Copenhagen / Malmö	Coastal	Baltic Sea	Trans-boundary, regional capital and metropolis.	CPH 549,050 (1,240,035) Malmö 303,873			X		X		X	X
Lisbon		West Atlantic	Dominant capital.	547,733 (2,042,477)	X	X	X		X		X	X
Barcelona		Mediterranean	Regional capital, port city; strong economic centre.	1,621,540 (3,218,071)	X	X	X		X	X	X	X
Istanbul		Bosporus	Megacity; primate city.	12,915,158	X	X	X	X	X	X	X	X
Milan/Turin	Inland	Northern Italy	Regional co-operation.	Milan 1,350,267 (3,202,947) Turin 905,352 (2,308,846)		X	X	X	X			X
Offenburg		Central Europe	Regional centre; small city.	59,283			X	X	X	X		X
Litomerice		Central Europe	Regional centre; small city.	25,000	X	X	X	X	X			X
Zagreb		Southeast Europe	historical centre.	790,000		X	X	X	X		X	X

[6] We assume that in the long-term 2050 outlook, Turkey will achieve a status comparable to an EU Member State and is therefore included as a case study city for the 2050 EU post-carbon cities roadmap.

Box 4: A typology of cities

City typologies are urgently needed to enhance the (trans)national transfer of best/good practices as well as mutual learning among cities. Such typologies would facilitate 'matchmaking' among cities and the joint development of solutions to common problems. POCACITO aims to close this research gap by developing a typology of cities (D2.4, WP2). This will help identify development paths for the case study cities, constituting an important input to the creation of scenarios for the case study cities, and the 2050 Roadmap.

III.I.III APPROACH

To conduct foresight activities and enhance mutual learning within the case studies, POCACITO uses a participatory approach, which is regarded as essential for solving complex problems. A series of case study workshops will be held to develop post-carbon city visions and scenarios on how to reach these visions under different global contexts.

In total, five workshops will be conducted at the city level. Each will place particular emphasis on engaging stakeholders in an open dialogue. The assessment workshop will introduce the concept of post-carbon cities and present results from the initial analysis, while also allowing for feedback from the stakeholders in order to identify additional aspects that the initial assessment may have overlooked. The key performance indicators (D1.2) will serve as *guidelines*[7] for the initial assessment and allow stakeholders to identify areas of concern. Using the findings of the initial assessment and ensuing discussion, the project will work with the local stakeholders to identify the main issues and opportunities of the city, which lays the foundation for a participatory and localised approach throughout the subsequent workshops.

The initial assessment of case study cities using the key performance indicators will serve as a starting point for backcasting exercises (Section III.II) performed in the vision workshops, which allow stakeholders to analyse how the parameters will change under the sustainable, post-carbon vision for the city (Holmberg and Robèrt 2000). In doing so, stakeholders will be able to identify early warning signs for undesirable consequences based on current investments as well as cases where marginal changes are not sufficient (or even counterproductive) to reach long-term goals (Holmberg and Robèrt 2000).

During the vision workshop, stakeholders will develop a post-carbon vision for their city or have the opportunity to reassess existing roadmaps. Backcasting exercises will be performed with stakeholders during the vision workshops. Following the vision workshops, the scenario workshops will allow stakeholders to develop two qualitative scenarios describing the transition necessary to reach the post-carbon vision under global circumstances. This will include specific measures and strategies for urban management under different socio-economic and environmental trends presented as background conditions derived from global scenarios (Section III.III.III) and the local challenges identified in the initial assessment. The sensitivity model (see Section III.III) workshops will quantify these impacts and allow stakeholders to reassess and revise their strategies to transition towards a post-carbon society. Output from the case study workshops and research activities conducted

[7] It is understood that these indicators do not tell the entire story – many aspects of the city and daily lives of stakeholders cannot be quantified, yet are highly relevant.

throughout the project will feed into the development of guidelines for an EU 2050 Roadmap for post-carbon cities.

Box 5: "Reinventing the wheel"

For all the selected case studies, low carbon concepts either already exist or are under development. This poses both a threat and opportunity for project activities. For instance, it may be difficult to establish a collaborative relationship with officials from cities who are already well advanced in defining the low-carbon future of their city (as in the case of Barcelona). On the other hand, stakeholders and/or city officials may be less resistant to change if a low-carbon outlook for the future has been established. The project should use the opportunity to partner with current or previous initiatives and events (e.g., a POCACITO workshops in Zagreb will be held during energy week in mid-May and Mobility week in September).

POCACITO aims to take a structured, yet flexible, approach to case studies in order to accommodate for local circumstances. All case study leaders will meet with city officials by April 2014 (month 4) to discuss the timeline and approach for workshops as well as potential collaboration with other initiatives. A dedicated report (D3.1) will detail the methodological guide for initial assessment and the project meeting in June 2014 (month 6) will include an internal workshop to go over the methodology and format used for the case study workshops on vision and scenario building as well as the Sensitivity model (see Section III.III.IV).

III.II ASSESSMENT DIMENSIONS

It is difficult – if not counterproductive – to develop a narrow set of criteria to classify a city as post-carbon. Instead, POCACITO will use key performance indicators (D1.2) to help assess and guide post-carbon transitions.

Given the complexity of cities as social-ecological systems, there is a risk that urban problems are dealt with in a fragmented fashion, which may lead to "sub-optimised measures that are not integrated in a large enough system perspective" (Holmberg and Robèrt 2000). POCACITO selects the key performance indicators using a systems thinking approach by analysing the relationships, interlinkages and feedback loops within the urban system through a series of mind maps. Based on the qualitative analysis of relationships, the set of indicators will be narrowed down to minimise overlap, which is conducive to backcasting exercises (Holmberg and Robèrt 2000). The indicator selection and mapping process is an iterative process comprising discussions with partners and stakeholders, as most relationships are not straightforward and dynamic in nature.[8] The following section provides a general overview of important aspects of the pillars of sustainability, which serve as guiding principles for the selection and analysis of the key performance indicators for post-carbon cities developed by the project.

[8] D1.2 will describe this process in more detail.

Box 6: Sustainability (status) and sustainable development (process)

Since the World Commission on Environment and Development (the "Brundtland Commission") sought to address the problem of conflicts between environment and development goals by formulating a definition of sustainable development in 1987, many attempts have been made to narrow down the concept to make it applicable to different contexts or to reconcile the three classical pillars – environment, society, and economy. The Brundtland definition of sustainable development – i.e., development which meets the needs of the present without compromising the ability of future generations to meet their own needs – is a good starting point, but too vague for applying it to a project without defining it more precisely.

Mainly based on Keivani (2010) and UN-DESA (2013), Pisano, Lepuschitz, and Berger (2014) undertake a convincing attempt for framing urban sustainable development. They define a diagram for urban sustainable development, which is made up of six blocks.

1. the **social** perspective, including urban social inequalities, low income, poverty, crime and social exclusion, which can lead to socially deprived problem areas in urban centres or suburbs.
2. the **economic** development, which includes not only the economy, but also municipal finance in order to ensure provision of essential city services as well as social support activities.
3. the **environmental** aspects, which are two-fold: on the one hand, cities are the largest contributors of GHG emissions. On the other hand, cities and their citizens suffer from climate instability, floods, heat waves or hurricanes. Furthermore, urbanisation, urban sprawl and industrialisation lead to general environmental pollution, issues of resource management (particularly water) and loss of agricultural land.
4. the viewpoint of **access to utilities and infrastructure** determines, among others, the degree to which a city can become active in transition processes towards sustainable development since a city has more influence on utilities if they belong to the city or if the municipality is at least a shareholder.
5. the connections derived from **urban form and spatial development** have consequences for all the pillars of sustainable development and are therefore crucial in the urban context. Urban sustainable development can become reality if a conscious planning towards this end takes place.
6. the inclusions of **multi-level governance and institutional development** refers to the fact that a city is part of a larger system, e.g., the political system of the nation state. The issues of inter-city linkages or the relationship of the city with the surrounding area – which is usually responsible for delivering renewable energy – is also highly relevant.

For POCACITO, aspects of infrastructure, planning and governance are addressed in addition to the three pillars of sustainability. See also Section II.III.II.

III.II.I ENVIRONMENTAL

An integral aspect of post-carbon cities is concentrated on climate change mitigation efforts (Pisano, Lepuschitz, and Berger 2014). However, the specific levels of GHG emissions considered sustainable vary according to local circumstances. Investments in energy efficiency and renewable energy are of importance both for mitigation and energy security, as are adaptation measures to the growing threats of climate change.

Box 7: Climate and energy

CLIMATE CHANGE MITIGATION AND ADAPTATION

No level of mitigation efforts will completely prevent climate change impacts, making a certain level of adaptation inevitable. Conversely, without mitigation efforts, the severity of climate change impacts can reach a level that prevents adaptation from successfully taking place. Therefore, in respect to development policies and strategies on the city level, the concepts of mitigation and adaptation must be understood as mutually inclusive occurrences and should be addressed simultaneously (Klein et al.). The impacts of climate change on cities fluctuate, however, based on variations in geographical and socio-economic conditions among cities. For example, coastal cities will need to create different adaptation and mitigation strategies than mountainous cities. The economic sectors within cities also vary with some industries, such as tourism and agriculture, being more susceptible to climate change impacts than others. While adaptation and mitigation should both be considered in city policy and strategy planning, it is important that cities tailor such planning to their unique conditions in order to successfully maximise adaptation and mitigation efforts (Commission 2013).

ENERGY EFFICIENCY

The European Commission defined energy efficiency goals for 2020 whereby Member States have made a commitment to reduce consumption of primary energy by 20% (European Commission 2009). Under its Action Plan, this includes measures to “improve the energy performance of products, buildings and services, to improve the yield of energy production and distribution, to reduce the impact of transport on energy consumption, to facilitate financing and investments in the sector, to encourage and consolidate rational energy consumption behaviour...”(European Commission 2008).

A distinction should be made between “energy efficiency” and “energy savings.” Although the terms are often used interchangeably, “energy efficiency” refers to using less energy inputs per unit of economic activity. “Energy savings,” on the other hand, is a broader concept related to net consumption reduction (European Commission 2011).

In addition to climate and energy, post-carbon cities implement measures that protect the local and surrounding environment, such as the preservation of biodiversity and soil management. An efficient use of resources, waste management, and recycling are also integral features of post-carbon cities. Furthermore, air quality conservation is important to both the environmental quality and human health, as is the management of water (including freshwater) (UN-DESA 2013).

Box 8: Biodiversity and resources

MAINTAINING BIODIVERSITY

Biodiversity, commonly referred to as the "variety of life on Earth" (European Commission 2009) broadly refers to the great diversity of living organic matter, which inhabits a space. The European Commission defines biodiversity or "biological diversity" as "one of the key terms in conservation, encompassing the richness of life and the diverse patterns it forms." The Commission notes that the Convention on Biological Diversity (CBD) defines biological diversity as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems"(European Commission 2014). As the UNEP (2014) notes, the term biodiversity commonly refers to "the number, variety and variability of living organisms." This term can be further described in terms of "gene species and ecosystems, corresponding to three fundamental and hierarchically-related levels of biological organisation," which include, but are not limited to genetic diversity, species diversity, and ecosystem diversity (UNEP 2014).

SUSTAINABLE USE OF RESOURCES

Resource efficiency is "the relationship between a valuable outcome and the input of natural resources required to achieve that outcome. It is the general concept of using less resource inputs to achieve the same or improved output" (Fischer-Kowalski et al. 2011, 5).

III.II.II SOCIAL

Post-carbon cities aim to improve the quality of life of all inhabitants. The cornerstone of this dimension is equity – both within the current generation (intra-generational equity) and also between generations (inter-generational equity). This is challenging because "cities are prone to huge intra-urban social inequalities" (Keivani 2010, p.7). Equity is supported by measures that enhance social inclusion and instil high education and health (including mental health) standards for all inhabitants. Low unemployment and poverty are important aspects of post-carbon cities as well as strong governance structures. Although difficult to measure, a positive sense of culture, community and the public realm improves the quality of life of city inhabitants (Putnam 2001; Kenworthy 2006) and could support the post-carbon transition process by enhancing responsibility for "the commons" and civic engagement, thereby increasing a city's social capital (Kenworthy 2006).

Box 9: What does equity mean?

When referring to the concept of equity, POCACITO uses the definition provided by (Beder 2000, p. 1) who states that "equity means that there should be a minimum level of income and environmental quality below which nobody falls. Within a community it usually also means that everyone should have equal access to community resources and opportunities, and that no individuals or groups of people should be asked to carry a greater environmental burden than the rest of the community as a result of government actions. It is generally agreed that equity implies a need for fairness (not necessarily equality) in the distribution of gains and losses, and the entitlement of everyone to an acceptable quality and standard of living".

The project will help stakeholders define equity – to identify the minimum levels of income and environmental quality – for their post-carbon city vision.

The social dimension is intimately related to the environmental and economic aspects of a city, adding to its complexity. For instance, the provision of green space could improve biodiversity and enhance the mental health of inhabitants, an accessible transit system could enhance the mobility of marginalised populations, and investments in renewable energy have the potential to lower unemployment. Likewise, economic and environmental measures could adversely affect social aspects – mitigation activities may harm industries that provide jobs to certain groups of the population, higher densities may undermine mental health, etc. Due to the complex relationships and the inability to quantify many important social aspects of cities, POCACITO will place a particular emphasis on this dimension during stakeholder activities and the assessment process.

III.II.III ECONOMIC

The economic health[9] of a city is an important component of the overall resilience of the system and the quality of life for its inhabitants. A green economy focuses on improving human well-being and social equity while significantly reducing environmental risks and ecological scarcities instead of solely achieving gains in traditional economic indicators. In addition to a strong, green economy, post-carbon cities have stable municipal finances, low unemployment and high employment in green jobs, which are defined by the UNEP (2008) as:

> "MANUFACTURING, RESEARCH AND DEVELOPMENT (R&D), ADMINISTRATIVE, AND SERVICE ACTIVITIES THAT CONTRIBUTE(S) SUBSTANTIALLY TO PRESERVING OR RESTORING ENVIRONMENTAL QUALITY. SPECIFICALLY, BUT NOT EXCLUSIVELY, THIS INCLUDES JOBS THAT HELP TO PROTECT ECOSYSTEMS AND BIODIVERSITY; REDUCE ENERGY, MATERIALS, AND WATER CONSUMPTION THROUGH HIGH EFFICIENCY STRATEGIES; DE-CARBONIZE THE ECONOMY; AND MINIMIZE OR ALTOGETHER AVOID GENERATION OF ALL FORMS OF WASTE AND POLLUTION".

As in the case of smart cities (see Box 2), technological innovation and integration are integral aspects of post-carbon cities. Investments in information communications technology (ICT) and other innovative industries aim to address environmental and social concerns, such as increased populations, polarised economic growth, increased GHG emissions, and decreased public budgets (Ogorkiewicz and Falconer 2013).

Box 10: Growth vs. degrowth?

Environmental and social challenges call into question whether current economic growth patterns can continue as they compromise efforts to achieve environmental and social sustainability. The current economic model is based on the idea that the economy should continuously grow as measured by GDP (Kallis, Kerschner, and Martinez-Alier 2012). Alternatives to traditional growth have become part of the economic vernacular including inclusive, sustainable, green, and smart growth. Though these concepts differ in meaning, their commonality is an expansion of the economic debate so that cities can consider economic development in not only monetary but also non-monetary terms. Two alternative economic models in particular exist to challenge this traditional economic model. They are a-growth and degrowth.

In the a-growth economic model, environmental, social, and economic policies are made with no consideration given to GDP or economic growth. The model claims that since GDP fails to accurately measure

[9] Traditionally, the health of a city's economy has been measured by growth in GDP or Gross Value Added (GVA). Although these indicators hold value for a city's economy in their own right, they fail to account for other important factors such as job availability, housing and transport infrastructure (PwC and Demos 2012). New concepts, such as green economy, have arisen to expand the traditional means through which cities can become economically vibrant.

important factors such as social welfare and therefore limits progressive policymaking in fields like labour, climate, health and public utilities, it should not be used as an indicator to judge economic success (van den Bergh 2010).

Although there are varying definitions of degrowth, a common definition is the conscious, gradual, and stable shrinking of the economy so that it can operate within an environmentally sustainable capacity. Degrowth recognises that there is a strong relationship between economic growth and environmental damage such that when one decreases, so does the other. Degrowth advocates measures that may require a significant redistribution of income and increase in taxes but is seen by its advocates as the only model under which a society will accept such necessarily stringent environmental policies (C.J.M. van den Bergh and Kallis 2012).

POCACITO does not take a normative stance on the growth vs. degrowth debate and rather leaves the discussion to the cities themselves.

III.III FRAMEWORK FOR ANALYSIS

The following section presents an overview of the main assumptions made by the project in respect to the territorial and system boundaries used for analysis as well as the time period and intervals. These assumptions establish the main framework for the qualitative and quantitative analyses of the project. Furthermore, the rationale for using the sensitivity model to quantify the vision and scenarios is provided.

III.III.I SPATIAL BOUNDARIES

The spatial system boundaries of the case studies are of the most critical and influential issues of the project assessment. The carbon footprint of a city largely depends on how the system boundaries around the cities are set. It is therefore critical that the case studies choose the same method for setting the spatial boundaries for the initial assessment and city scenarios. In this context, the spatial system boundaries are related to the boundaries (borders) that should be used to define the city as well as the activities of the city. This incites several questions that need to be agreed upon for the evaluation of case study cities. For instance, should citizen consumption be taken into account or should the analysis be limited to the issues that are under governance by the city regulators? How should imports and exports be accounted for? These questions are relevant because some cities have industries with production sites that are important single emission sources and also produce a large amount of exported goods and services, whereas other cities have no major industrial sites and lower exports.

CITY

How wide the spatial boundaries of a city are will make a substantial difference on the analysis. There is a trade-off between the thoroughness of the analysis and handling of data (both in terms of data quantity and availability). As many city “users” live outside the CBD (Central Business District), the city as a functioning entity is intimately bound to the surrounding suburbs. At which point those suburbs are deemed outside the scope of the city or belonging to a neighbouring city is a contentious issue. In these situations, standards typically delineate the boundaries of an entity as those which the entity has control over (such as scope 1 of the GHG Protocol). The different types of city geography development play a large role here. Suburbs typically “serve” the city in that they are designed around a city for the purpose of providing people (employees) for the city or for access to the cities facilities. In spite of this, the suburbs may not be under the control of the actual city council.

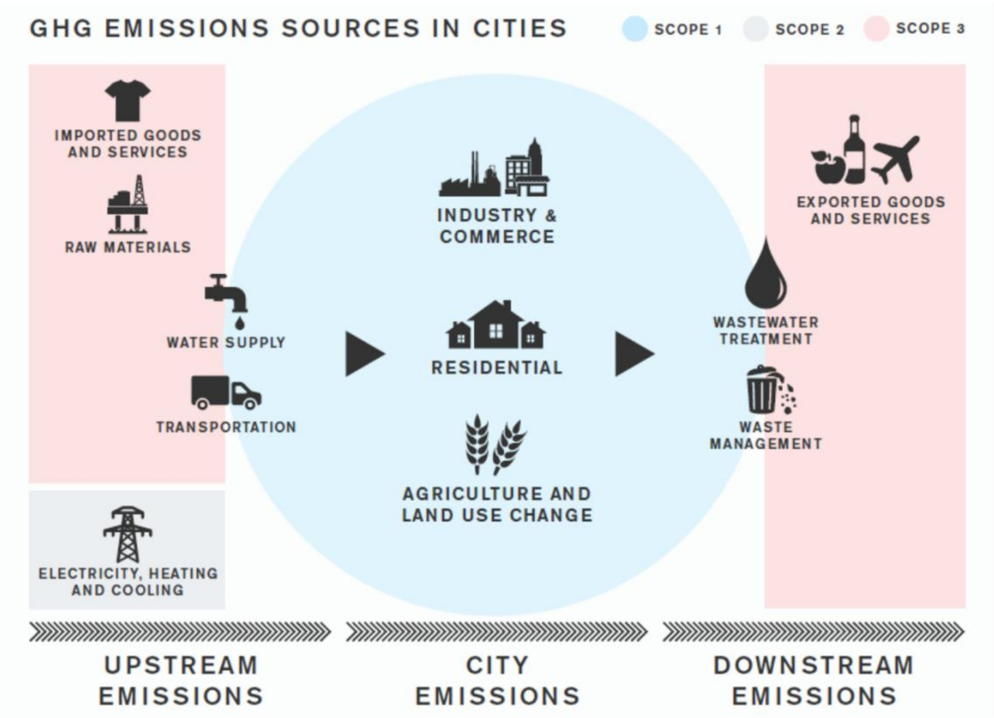
This is perhaps much different for a "greenfield" city development such as Perth, Australia with a large sprawl of new greenfield suburbs, as opposed to more brown field development in many European locations. That is to say that old villages that were once separated from a city become increasingly linked to a city by the movement of people and improved transport linkages. Important studies such as Jones and Kammen (2013) have shown that the lower carbon footprint of the high density urban core is undermined by the surrounding suburbs.

There needs to be some agreed way of how to develop inclusion criteria, e.g., should it be based on the percentage of people in an area that work in a city, or in relation to the transport linkage or frequency. This ideally should be the same for all case study cities to allow comparisons. The defined boundaries of the case study cities are critical to assess the impact of the city today and, more importantly, to understand how the post-carbon scenario could reduce the impact. How the city is designed in tandem with the suburbs, in terms of transport linkages, symbiotic exchanges (e.g., district heating, reuse of by-products in local agriculture) is fundamental.

CARBON REPORTING

Existing methodologies provide different approaches to carbon reporting calculations. Many of the approaches present the resulting emissions divided into the scopes developed by the Greenhouse Gas Protocol and implemented into the Global Protocol for Community (GPC) Scale Emissions (Greenhouse Gas Protocol 2014). Scope 1 comprises the emissions within the city boundaries, scope 2 represents upstream emissions connected to energy supply, and scope 3 includes upstream and downstream emissions from imports and exports (Figure 4).

Figure 4: Illustration of the different scopes of reporting greenhouse gas emissions for cities



Source: BSI 2013, adapted from Wright et al. 2011

The PAS 2070 Specification for the Assessment of Greenhouse Gas Emissions of a City (BSI 2013) provides two different methods for reporting greenhouse gas emissions: a consumption based (CB) method and a so called Direct plus supply chain (DPSC) method. The CB method includes direct and life cycle GHG emissions for all goods and services consumed by residents of a city, i.e., GHG emissions are allocated to the final consumers of goods and services rather than to the original producers of those GHG emissions. Included emission sources are the combustion of fossil fuels in homes and vehicles, and indirect emissions associated with the consumption of all goods and services by residents. Ideally, consumption should be included for the following reasons:

- the upstream impacts of a city can be the biggest.
- without the up-stream emission, cities with more services would come out more favourably, but may actually have a higher overall footprint.
- if consumption was not included then it could distort development of the post-carbon scenario by shifting the impacts outside the city boundaries.

For the calculation of supply chain emissions – both upstream and downstream – the methodology uses an environmentally extended input-output model (EEIO) based on financial flow data from national or regional economic accounts combined with environmental account data. It excludes emissions connected to export and does not use the scopes for presenting the results.

The Direct plus supply chain (DPSC) methodology builds on the Global Protocol for Community Scale Emissions (Greenhouse Gas Protocol 2014) and includes a large number of emissions sources, namely:

- Stationary sources of GHG emissions (i.e., energy plants and buildings)
- Mobile sources of GHG emissions (i.e., different modes of transport)
- GHG emissions from industrial processing and product use (IPPU)
- Agriculture, forestry and land use (AFOLU)
- Waste and wastewater treatment
- Goods and services

The resulting emissions are reported for the three scopes presented above.

However, the consumption based approach for measuring greenhouse gas emissions excludes many of the emission sources that the city may have direct or indirect governance over, such as the production of energy and energy use in public buildings. This may lead to lack of incentives to improve the footprint of energy production and energy use, which could potentially improve the total carbon emissions of the city drastically. Exclusion of export related emissions leads to a less complete emission inventory. On the positive side, the extended input-output model approach ensures a comprehensive coverage of upstream and downstream emission sources and saves time in the data collection, although the translation from economic value into emissions may be complicated. The

Direct plus supply chain methodology is more comprehensive in its scope and follows the relatively well established GPC methodology. The different emission source categories make the reporting transparent, although data collection for all categories may be difficult and time consuming.

III.III.II TEMPORAL SCOPE

In addition to the spatial boundaries of the city and of the carbon reporting, the time period chosen for the analysis is crucial as it must be representative of the city under analysis. For example, due to the financial crisis, 2008 is not a representative year for the majority of the case study cities because energy use, etc. would have been different as compared to normal conditions.

The chosen reference year for case studies should be as recent as possible and still be representative of average "normal" conditions in the city during the last decade. Choosing a reference year from far in the past would probably result in evaluation results that are overly positive. It would also generate unnecessary historic information. Although the development from i.e., 1990 up until present day may be interesting from a historical perspective, the main objective of the project is to investigate future developments using backcasting methods to get from the current status to the future post-carbon vision for each case study city. In order to have the most relevant baseline, 2012 or even if possible 2013 would be the most desirable reference year.

On the other hand, if the reference year is too close to present day, data availability may be limited. Many statistical databases (i.e., Eurostat) normally take at least a year to populate with data from the previous year. In some cases, data are collected on a bi-yearly basis or more rarely, which implies that data can be missing for some years. It is recommended that data availability for the selected indicators should be the main basis when deciding on reference year for the case study cities.

It is also preferable that the reference year is the same for all of the case study cities. However, since the main objective is not to compare cities with each other (as they may be difficult to compare for other reasons as well (size, location, demography, level of technology etc.), but to evaluate the progress of each individual city, slightly different reference years could be chosen if this is due to data availability reasons. As long as the reference years do not differ more than five years between the case study cities, different years should be tolerated. Even if different reference years are used, the relative improvement (in % of distance to target) of the cities can still be compared; i.e., how far have they come on their path to the post carbon vision. One outcome of using different years may be different data quality, given that the same or similar data sources are used. However, since the data are generated by different people in different countries, using the same year is no guarantee of equal data quality. Since the cities may use quite different data sources for their indicators, as well as different scope, the choice of reference year will probably have a relatively small impact on data quality and comparability.

As the cities develop towards the post carbon scenarios, a quantitative analysis of this development will be compared to "business as usual" scenarios with either 10 or 20 year intervals. The intervals used for evaluation of progress should be the same, as should the end year – 2050 – although using the same end year may make the last interval before the target year different for the cities (if the case of different reference years).

III.III.III GLOBAL SCENARIOS

Within the POCACITO roadmap exercises, external common scenario frameworks, possibly on a global scale, will be used in order to define boundaries for the local scale scenarios. The advantage of using external reference scenarios or storylines, in the local visioning exercise is twofold: (a) it provides boundaries and directions for the formulation of visions, assuring that common issues are addressed in all local exercises, and (b) it links the visioning and successive backcasting exercise to global scientific reflections on possible futures, both on the socio-economic as well as the physical environment.

Two different options can be considered for the construction of a scenario framework. The first is a schematic "scenario axes" approach (van't Klooster and van Asselt 2006) as used, for instance, in the Millenium Ecosystem assessment exercise (Millennium Ecosystem Assessment 2005). The scenario axes approach is based on the selection of the two most relevant driving forces for the future development of the topics under scrutiny, either because of their importance for determining future impacts or because of the high grade of uncertainty attached to future events. Key dimensions to be considered in a scenario building exercise will need to be selected from issues recognised as either driving forces for post-carbon developments, and/or recognised as particularly fraught with uncertainty, so that exploring different future alternatives will provide useful insights into the range of possible future developments of these issues. Assuming two opposite directions of change (e.g., high/low GHG emissions) for each of these two drivers and that the two drivers are roughly orthogonal (not correlated with each other), a total of four different scenarios could be developed. This allows the boundaries of developments under different pathways for these driving forces to be explored.

The second approach (global scenarios hereafter) refers to the new scenario framework being developed in the climate research community. Scenarios for future greenhouse gas emissions and concentration pathways (the so-called Representative Concentration Pathways, RCPs) are combined with a set of socio-economic scenarios, which facilitate the exploration of factors important for the assessment of future mitigation and adaptation activities (Kriegler et al. 2012; van Vuuren et al. 2012). This new framework of socio-economic scenarios is expected to be published within the next WGIII contribution to the Fifth IPCC Assessment report in the beginning of April 2014[10] and substitute the SRES Scenarios (Nakićenović et al. 2000), which have been the main reference for scenario building exercises during the past decade. Although the main focus is on climate-change-related issues, some important dimensions that are potentially relevant for the design of local post-carbon visions and scenarios are expected to be treated in either a qualitative or a quantitative manner. Population and income growth, primary energy consumption, governance, technology development, and international cooperation are among the driving forces considered in this framework (van Vuuren et al. 2012).

The advantage of the scenario axes option – where two key dimensions are combined with contrasting conditions – is that it allows for the definition of a very specific POCACITO scenario framework, which is able to address the issue of the transition of post-carbon scenarios. The

[10] Please refer to http://ipcc.ch/report/ar5/outreach.shtml, accessed on 17/03/2014

advantage of the IPCC scenario is that local scenarios will potentially be able to refer to 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 draw-back of the solution is the time frame for the new socio-economic scenario framework as it is not published yet. However, deadlines seem to be potentially compatible for their inclusion into the scenarios to be proposed for the case study exercises. Note that, in principle, the two 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 IPCC scenarios. This would, in principle, be a highly advisable course of action, but it is subject to a preliminary check of its feasibility since it is only possible when IPCC scenarios are released.

Both options will lead to the definition of a reduced set of common scenarios or storylines, which can then be translated in each case study in strategic backcasting scenarios for the transition process. These strategic scenarios will be combined with the visions formulated in the first step of the case study workshops where participants will explore ideas and expectations on a post-carbon future for their city.[11]

III.III.IV MODELLING

In order to establish a baseline and track the progress case study cities make towards their post-carbon vision, a comprehensive model is needed that takes all relevant aspects into account. Since the nature of the cities is very diverse, the model needs to be adaptable to each case study, but still use the same set of guiding principles.

There are many different models and standards for assessing environmental impact and sustainability of cities. A large number of methods and tools focus on carbon reporting, such as the Global Protocol for Community (GPC) Scale Emissions (Greenhouse Gas Protocol 2014)[12], the Harmonized Emissions Analysis Tool plus (ICLEI 2014), the carbon Cities Climate Registry (cCCR) (Carbonn 2014), and the newly developed standard PAS 2070 (BSI 2013) released in 2013. The Sensitivity model of Prof. Vester (Vester 2001) is a participatory methodology developed to deal with complex issues and systems, which is suitable for the purposes of the project.

Although standardised methods for carbon reporting are rigid in their structure, they require all cities to report on the same indicators. This is needed to ensure comparability, but may lead to omission of important factors or indicators for some cities. The Carbonne Cities Climate Registry has a more stepwise approach; where it is allowed to start with entering limited amount of data that are readily available. With time, this data can be complemented as knowledge increases and more data are collected. This approach is more “forgiving” for cities that lack experience and resources to comply with a more complex standard, and can be used for tracking of internal progress. The categories are

[11] The format of the case study workshops will be discussed during the internal project meeting in June 2014 (month 6).

[12] The GPC methodology was developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCDS). Other stakeholders involved in the development of the standard are ICLEI- Local governments for sustainability, C40 Cities Climate Leadership Group, the World Bank, UN-HABITAT and UNEP (UN Environment Program). The first version (1.0) of the standard was released in May 2012, and is currently being tested by 33 cities worldwide. The outcome of the test period is expected during 2014. An expanded version of the GPC protocol is expected in 2015, including more detailed guidance on scope 3 (full value chain assessment).

still fixed however, and do not leave any option for the city representatives to add any new indicators or topics. Even if most standards have been developed with feedback from city stakeholders (i.e., the pilot testing of the GPC methodology), they cannot be adjusted to fit every city based on their specific characteristics. The sensitivity model was chosen because of its participatory approach and flexibility. Berardi (2013) compared different rating systems for sustainability of cities. The assessment showed that an increase in citizen engagement in the selection of assessment criteria is necessary to share priorities and customize sustainability goals for each community. This promotes participatory approaches such as the sensitivity model.

The following steps describe the Sensitivity model approach and how it will be applied to the case study cities:

I. Stakeholders from different disciplines and backgrounds, who usually do not work together, are gathered to assess an issue(s) – in this case the carbon footprint and other environmental, social and economic aspects of a city or community. The participants describe the city as a system and agree on a number of important factors that influence the system in its transformation towards a post-carbon scenario. This is achieved by mapping of seven parts that are always included in complex systems, such as cities:
    - **Actors/stakeholders:** who act in the city?
    - **Activities:** What do the actors do in the city?
    - **Place:** Where do the actions take place?
    - **Feelings:** How do the actors feel?
    - **Environment:** How does the city influence the environment?
    - **Infrastructure:** How is the city organised?
    - **Governance/regulation:** How is the city governed today?

II. The links and interdependencies between factors are identified. The factors can be anything influencing the future scenarios, including citizen behaviour and habits, the city goals and visions, and information flows. By visualising the connections between the factors with direct (solid) and indirect (dotted) arrows, the direction and degree of the influence/dependence is shown.

III. The role that each factor plays in the city development is identified, and again the interdependencies of the factors are studied in detail and quantified.

IV. The most critical parts of the system are selected for further investigation and analysis. An example of such part or sub system could be the energy supply of the city, where the supply chains and influencing regulations and policies could be mapped in more detail.

V. For each factor, prognosis of cause and effect are studied, using an “if-then” approach. In other words, if a certain parameter changes in one direction, what effect does that have on the city as a system and how does it affect the development towards the post carbon scenario? This is done using a dependence matrix featuring all factors on both the X- and the Y axis, and the strength of the connection between factors is illustrated by a number between

0 and 3. By changing the numbers, one gets an understanding of how the system changes with varying interconnections.

VI. The developed system of interconnected factors is then evaluated in terms of robustness and sustainability. This is managed by rating system properties such as self-regulation, independence of growth, recycling, and multiple use on a scale between 0 and 100. When the key factors have been identified, they are used to develop strategies aiming to reach the post-carbon target scenario of the case study cities.

The model has been developed into a software that visualises and guides the steps described above.[13]

Each city will have its own focus as well as its own set of unique challenges in terms of impacts in addition to the common concerns and impacts for all cities. Hence, the sensitivity model is used to determine the unique set of factors to model and study for that city, since it is not possible to focus on all aspects. For example, energy and GHG emissions will be modelled for all cities, but for some this could be linked to water quality and nutrient run-off from local agriculture. Hence, the use of nitrogen fertilisers could be causing extensive GHG emissions as well as acidification and eutrophication impacts. These specific characteristics are captured by the sensitivity model approach, which involves many different stakeholders and shapes the assessment around the most critical factors for each city.

[13] The software and its different interfaces are presented in more detail by Management Zentrum St. Gallen and on the website www.sensitivity-model.com.

IV NEXT STEPS

The purpose of the Common Approach Framework Document is to clarify key concepts, terminologies and assumptions that are fundamental to the project activities. The information presented above will serve as a reference for all project activities in order to ensure consistency and enhance the comparability of results.

Furthermore, the Common Approach facilitates the ongoing knowledge exchange and discussions between partners and stakeholders. As a living guidance document, the Common Approach will be revised and updated to reflect developments in the literature, discussion among partners as well as feedback from stakeholders. It serves as a good basis and way forward for project activities hereafter. The glossary found below – which compiles definitions taken directly from the literature cited – will continue to expand throughout the duration of the project, feeding into subsequent reports and publications. Partners are encouraged to add to the list by defining additional terms that are essential to the project and concept of post-carbon cities.

Despite the in-depth review of key concepts and terminologies, there are still several practical issues that need to be addressed. First, the key performance indicators must be defined in order to harmonise the initial assessment of cities – this will be done in the *Report on Key Performance Indicators* (D1.2). The methodology used for the initial assessment will be detailed in the *Methodological Guide for the Initial Assessment* (D3.1). Furthermore, the implementation of case study workshops – i.e., the methodology, design, and format – will be addressed in order to ensure the successful application of the theoretical concepts introduced in this document. Additionally, case study leaders will attend an internal case study workshop (lead by FEEM) at the next project meeting (month 6, June), which will further clarify the approach to the case study workshops. An interactive session on the Sensitivity model will also take place at the project meeting in June 2014 (month 6). During this session, IVL will present the specifications of the model in further detail and conduct a demonstration of the sensitivity model case study workshop with project partners acting as stakeholder participants.

In the meantime, follow-up web conferences will be used to clarify the spatial and temporal boundaries as well as the global scenarios used for the qualitative and quantitative analyses of the project – the respective Work Package leaders are organising these accordingly and the internal intermediate deadlines for these activities can be found on the internal area of the project website. As the coordinating partner, Ecologic Institute will ensure that these deadlines are met by the responsible partners and update the Common Approach Framework document to reflect these milestones.

GLOSSARY OF TERMS

Adaptability

The ability of stakeholders to improve its resilience (Berkes, Folke, and Colding 2000; Folke et al. 2004; Gallopín 2006; Lebel et al. 2006; Olsson et al. 2006) to fluctuating environmental and socio-economic pressures, such as climate change, long-term changes in urban resident demographics, city and rural migration patterns, and health concerns (Walker et al. 2004).

A-growth

In a-growth, environmental, social, and economic policies are made with no consideration given to GDP or economic growth (van den Bergh 2010).

City

Cities are complex, adaptive, social-ecological systems (SES) (Levin and Harvey 1999; Berkes, Colding, and Folke 2003; Gunderson and Holling 2001; Norberg and Cumming 2008; Evans 2008) "characterised by a particular human settlement pattern that associates with its functional or administrative region, a critical mass and density of people, man-made structures and activities" (UNEP 2011).

Degrowth

The concept of sustainable degrowth assumes a downscaling of production and consumption that increases human well-being and enhances ecological conditions and equity on the planet. It calls for a future where societies live within their ecological means, with open, localised economies and resources more equally distributed through new forms of democratic institutions (Research & Degrowth 2014).

Eco-City

An urban environmental system in which input (of resources) and output (of waste) are minimised (Register 1987).

Eco-innovation

Eco-innovation can be defined as "[…] the introduction of any new or significantly improved product (good or service), process, organisational change or marketing solution that reduces the use of natural resources (including materials, energy, water and land) and decreases the release of harmful substances across the whole life-cycle" (Eco-Innovation Observatory 2010).

EcoMobility

EcoMobility is defined as travel through integrated, socially inclusive, and environmentally-friendly and sustainable transport options, including and integrating walking, cycling, wheeling, and passenging. By enabling citizens and organisations to access goods, services, and information in a sustainable manner, EcoMobility supports citizens' quality of life, increases travel choices, and promotes social cohesion (ICLEI 2011). EcoMobile transport choices have low to no emissions compared to the personal automobiles powered by fossil fuels. EcoMobility supports the use of light electric vehicles, provided that the source of the electricity is from renewable energy sources (ICLEI 2011).

Energy Efficiency

Energy efficiency means using less energy inputs while maintaining an equivalent level of economic activity or service (European Commission 2011).

Energy Savings

Energy saving is a broader concept that also includes consumption reduction through behaviour change or decreased economic activity. Examples of energy savings without efficiency improvements are heating a room less in winter, using the car less, or enabling energy saving modes on a computer (European Commission 2011).

Equity

Equity means that there should be a minimum level of income and environmental quality below which nobody falls. Within a community it usually also means that everyone should have equal access to community resources and opportunities, and that no individuals or groups of people should be asked to carry a greater environmental burden than the rest of the community as a result of government actions. It is generally agreed that equity implies a need for fairness (not necessarily equality) in the distribution of gains and losses, and the entitlement of everyone to an acceptable quality and standard of living (Beder 2000).

Foresight

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),

Green Economy

A green economy results in improved human well-being and social equity while significantly reducing environmental risks and ecological scarcities. A green economy is resilient and provides a better quality of life for all within the ecological limits of the planet (Green Economy Coalition 2014). In its simplest expression, a green economy can be thought of as one which is low carbon, resource efficient and socially inclusive (UNEP 2011).

Green Growth

Green growth is growth, which is efficient in its use of natural resources, clean in that it minimises pollution and environmental impacts, and resilient in that it accounts for natural hazards and the role of environmental management and natural capital in preventing physical disasters (The World Bank 2012). The term also refers to promoting economic growth while reducing pollution and greenhouse gas emissions, minimising waste and inefficient use of natural resources, and maintaining biodiversity while improving health prospects for populations and strengthening energy security through less dependence on imported fossil fuels. Green growth entails investing in the environment as a driver for economic growth (OECD 2013) and meeting the needs of the present generation without compromising the ability of future generations to meet their own needs (United Nations 1987).

Green Public Procurement

Green Public Procurement (GPP) is defined as the approach by which public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured (European Commission 2008) and integrate environmental criteria into all stages of their procurement processes. GPP considers the cost of procured goods/services over their whole life (EnviroCenter.ie 2014).

Impact

Impact is a change in economics, the environment, society, health and/ or well-being to a particular project, program or policy (The World Bank 2011).

Inclusive Growth

Economic growth that results in a wider access to sustainable socio-economic opportunities for a broader number of people, regions or countries, while protecting the vulnerable, all being done in an environment of fairness, equal justice, and political plurality (Ranieri and Almeida Ramos 2013).

Indicator

An indicator quantifies and simplifies phenomena and helps us understand complex realities as well as changes in a system. An indicator quantifies and aggregates data that can be measured and monitored to determine whether change is taking place (Food and Agriculture Organization of the United Nations 2014).

Megacity

A megacity is a city that has at least 10 million inhabitants (Department of Economic and Social Affairs, Population Division 2012) and is often made of two or more urban areas that have grown so much that they are connected (Cambridge Dictionaries Online 2014).

Monocentricity

Monocentricity refers to an urban setting where the population is concentrated in one urban centre (Meijers and Burger 2010).

Neighbourhood

Neighbourhood is the bundle of spatially based attributes associated with clusters of residences, sometimes in conjunction with other land uses (Galster 2001).

Paradigm Shift

A fundamental change in approach or underlying assumptions (Oxford Dictionaries 2014).

Participatory Scenario Development

Participatory scenario development is a process that involves the participation of stakeholders to explore the future in a creative and policy-relevant way (Bizikova, Boardley, and Mead 2010).

Passive Solar Design

The ecological design, together with a mixed land use, that enhances energy efficiency (Jabareen 2006).

Peripheralisation

The process through which specific sections of urban populations become disconnected from and dependent on particular urban centres is known as 'peripheralisation'"(Naumann and Fischer-Tahir 2013).

Polycentricity

Polycentricity refers to an urban population, which is spread over multiple urban centres in a metropolitan area in a balanced way (Meijers and Burger 2010).

Post-carbon City

The concept of "post-carbon cities" signifies a rupture in the carbon-dependent urban system, which has lead to high levels of anthropogenic greenhouse gases, and the establishment of new types of cities that are low-carbon as well as environmentally, socially and economically sustainable. The term post-carbon emphasises the process of transformation, a shift in paradigm, which is necessary to respond to the multiple challenges of climate change, ecosystem degradation, social equity and economic pressures. Through their adaptive capacity, post-carbon cities use the threat of climate change "as an opportunity to reduce vulnerability as they restructure human–ecological and human–human relationships toward ecosystem health and a clean energy economy"(Evans 2008, p.3; based on Adger 2006; Neil Adger, Arnell, and Tompkins 2005).

Public transportation

Public transportation includes all multiple occupancy vehicle services designed to transport customers on local and regional routes. It is transportation by van, bus, or rail or other conveyance, either privately or publicly owned, providing to the public general or special service (Idaho Transportation Department 2013).

Resilience

The capacity of an urban system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks (Walker et al. 2004).

Resource Efficiency

Resource efficiency means creating more socio-economic value with an equal level of resource input or an equal level of environmental impact, thus resulting in an increase in resource productivity. Resource efficiency increases can occur at all stages of a good's life cycle (extraction, production, distribution, consumption or disposal) and it can be measured on different scales, e.g. for one product group, economic sector, consumption field, or for the economy as a whole (Umpfenbach 2013).

Scenario

A scenario is a policy analysis tool that describes a possible set of future conditions. These descriptions of journeys to possible futures reflect different assumptions about how current trends will unfold, how critical uncertainties will play out and what new factors will come into play (Moniz 2005).

Smart City

Cities that use innovative solutions mainly linked to the investment in technology to address burgeoning municipal problems. The term “smart” is usually a shorthand reference to public or private investment (in this case at a municipal level) in information communications technology (ICT), or “smart” industries and other industries implying ICT in their production processes (Rudolf 2007). Investment can take on many shapes to address a wide area of issues facing cities including, but not limited to the following: increased populations, polarised economic growth, increased GHG emissions, and decreased budgets (Ogorkiewicz and Falconer 2013).

Stakeholders

A stakeholder is any individual, organisation, sector or community who has a ‘stake’ in the outcome of a given decision or process (Stakeholder Forum for a Sustainable Future).

Sustainable Growth

Sustainable economic growth in operational terms is the upward trend in environmentally adjusted net domestic product (EDP) under certain conditions and assumptions (United Nations 1997).

Sustainable Transportation

Sustainable transportation emphasises the reduction of CO_2 emissions in transport, a reduction in transport noise at source and through mitigation measures to ensure overall exposure levels minimise impacts on health, the modernisation of public passenger transport services, and achievement of a greater decrease in transport-related deaths (Eurostat 2009).

Transition

A transition can be defined as a gradual, continuous process of change where the structural character of a society (or a complex sub-system of society) transforms. Transitions are not uniform, and nor is the transition process deterministic: there are large differences in the scale of change and the period over which it occurs. Transitions involve a range of possible development paths, whose direction, scale and speed government policy can influence, but never entirely control (Rotmans et al 2001, p. 16).

Urban Metabolism

The social as well as biophysical [means] by which cities acquire or lose the capacity for sustainability in the face of diverse and competing problems (Mitchell 1998).

Urban Sprawl

Urban sprawl is commonly used to describe physically expanding urban areas. Sprawl is the leading edge of urban growth and implies little planning control of land subdivision. The European Environment Agency (EEA) has described sprawl as the physical pattern of low-density expansion of large urban areas, under market conditions, mainly into the surrounding agricultural area. In this scenario development is patchy, scattered and strung out, with a tendency for discontinuity. It leap-frogs over areas, leaving agricultural enclaves. Sprawling cities are the opposite of compact cities — full of empty spaces that indicate the inefficiencies in development and highlight the consequences of uncontrolled growth (EEA 2006).

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