POCACITO

european post-carbon cities of tomorrow

FINAL SYNTHESIS BOOKLET

MAJOR FINDINGS AND OUTPUTS OF THE POCACITO PROJECT

ECOLOGIC INSTITUTE

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LIST OF ABBREVIATIONS

BAU	Scenario: Business as Usual
COM	Covenant of Mayors
EEA	European Energy Award
EU	European Union
GHG	Greenhouse Gases
KPI	Key Performance Indicators
PC2050	Scenario: PC2050
PCI	Post-Carbon City Index
SEAP	Sustainable Energy Action Plan
SM	Sensitivity Model
SSP	Shared Socio-economic Pathways
UNEP	United Nations Environmental Programme

ABSTRACT

Cities are of outstanding importance in addressing climate change since they are not only the centre of economic and social initiatives, but also responsible for the majority of global energy consumption and for approximately 60% of global greenhouse gas (GHG) emissions. Stakeholders at the city level thus face significant challenges, which are addressed by the European research project Post-Carbon Cities of Tomorrow (POCACITO), funded by the European Union's Seventh Framework Programme for research, technological development and demonstration. The POCACITO project facilitates the transition of cities to a sustainable or "post-carbon" economic and societal model in a global context. POCACITO uses a participatory approach that engages local stakeholders to create custom made transition strategies for ten case study cities. These strategies are then used to create a EU 2050 Roadmap, a stakeholder-driven guide towards the model "Post-Carbon City of Tomorrow" that merges climate, energy and social urban transitions. This booklet gives an overview of the POCACITO project, focussing on the methodology used and most importantly on the major findings, results and outcomes of the project.

I POST-CARBON CITIES OF TOMORROW

Cities cover only 2% of the Earth's surface, but nevertheless are responsible for over 78% of global energy consumption and over 60% of GHG emissions (UNEP 2011; UN Habitat 2016). Moreover, they are in the centre of economic and social initiatives, which is why they are of outstanding importance in addressing climate change. Rapidly growing urban populations in combination with the already visible and anticipated consequences of climate change lead to increasing pressure on the economic, environmental and social health of cities. Hence, local stakeholders are facing significant challenges and trade-offs (Ridgway et al. 2014).

The project Post-Carbon Cities of Tomorrow (POCACITO) addresses these challenges by developing strategic post-carbon transition pathways with a focus on towns, small and medium-sized cities, megacities, metropolitan areas and urban clusters larger than 1 million people.

POCACITO facilitates the transition of cities to a "post-carbon" economic and societal model in a global context. In order to achieve this goal, the project consortium produced local strategy papers, i.e., custom-made transition strategies, for the case study cities—namely Barcelona, Copenhagen, Istanbul, Lisbon, Litoměřice, Milan, Turin, Rostock, Malmö and Zagreb. Building upon these local strategies, POCACITO then developed a 2050 EU Roadmap, which is essentially a stakeholder-driven guide to creating the Post-Carbon Cities of Tomorrow, merging climate, energy and social transitions in EU cities.

The concept of "post-carbon cities", as it is defined in the POCACITO project, signifies a rupture in the carbon-dependent urban system, which has lead to high levels of anthropogenic greenhouse gases. It means 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—or a paradigm shift—which is necessary to respond to the multiple challenges of climate change, ecosystem degradation, social equity and economic pressure. 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).

This Synthesis Booklet presents the methodology used and the major findings and outcomes of the POCACITO project. It is structured as follows: the second section provides an overview of methodology used within the project. While section II.I describes the groundwork of the project, section II.II and II.III focus more specifically on the methodologies used within the individual tasks. Section III discusses the results of the project. Section III.I describes the Inventory of Urban Sustainability Initiatives, which is a knowledge base for cities globally and in particular for the Local Strategy Papers and the 2050 EU Roadmap. Results from these Local Strategy Papers and from the 2050 EU Roadmap are discussed in Sections III.II and III.III. Section IV concludes by summarising the impacts of the project and highlighting potential fields of further research.

II METHODOLOGY: A COMBINED QUALITATIVE AND QUANTITATIVE APPROACH

The POCACITO approach combines both qualitative and quantitative elements in order to support the transition of cities to a more sustainable or post-carbon future. Research activities ranging from the city to the global level point to the widespread nature of the project. This section focuses on the methodology of the project and its different research foci. Following the concept of **foresight**, all of the research activities carried out 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 (Ridgeway et al. 2014).

Section II.I focuses on the Post-Carbon City Index (PCI), which lays the groundwork for other research activities within the project. Building upon this groundwork, ten European case studies were carried out at the city level to develop custom made transition strategies. The methodology used within these case studies is the subject of Section II.II. The output from all case study activities conducted throughout the project fed into the development of guidelines for the EU 2050 Roadmap.

To provide and share knowledge on best practices globally, three inventories were developed: the Leading Cities Inventory (Beveridge et al. 2014), the Good City Practices Inventory (Döhler et al. 2014) and the Inventory of Good National and EU Practices (Beveridge & Döhler 2015). Together, they constitute an Inventory of Urban Sustainability Initiatives and at the same time contribute to a Typology of Cities developed specifically for the project. Next to other global activities carried out within POCACITO, both the inventories and the typology of cities will be described in Section II.III. Overall, these research activities aim at fostering debate and creating a global network of learning.

II.I THE POST-CARBON CITY INDEX

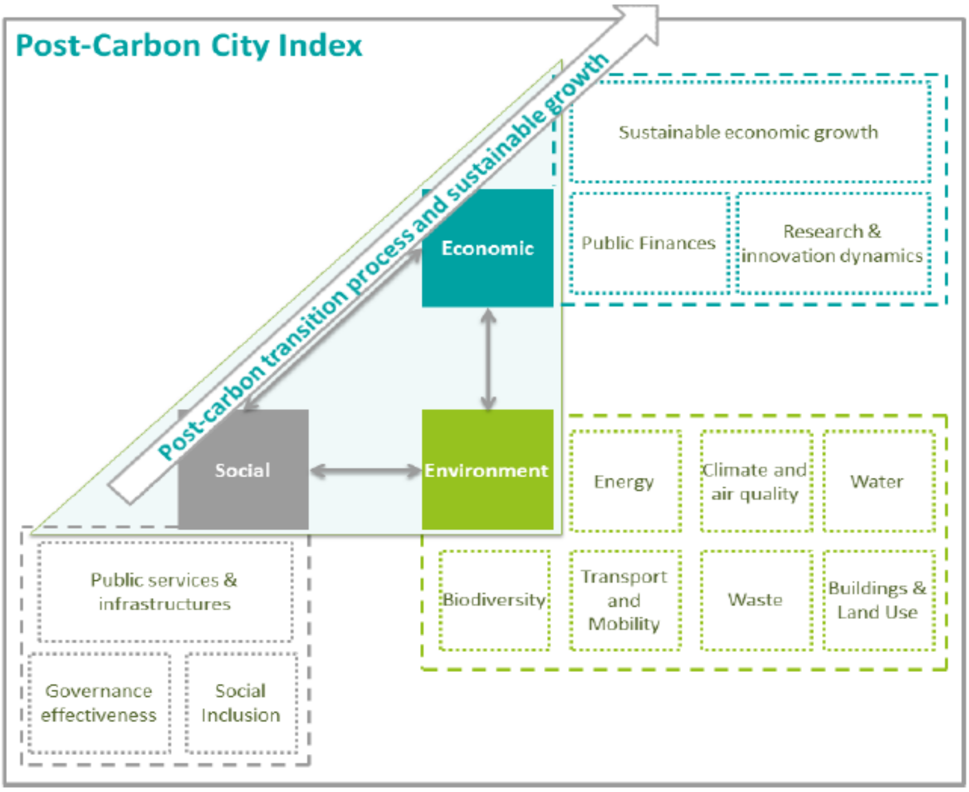
The PCI is a tool to assess and monitor the status quo and the transformation process of a city in transition. It is based on a set of Key Performance Indicators (KPIs), which allow for the uniform collection of data, facilitate benchmarking and aid in the identification of best practices. The KPIs build on existing tools such as the Green Cities Index (Denig 2012), material flow analysis methods (OECD 2008; Rosado et al. 2014) and urban metabolism (Kennedy et al. 2010) coupled with life cycle analysis methodologies (Goldstein et al. 2013) and thus enable the measurement of societal transformations occurring within a transition city.

A complete list of KPIs is provided in Silva et al. (2014). As Figure 1 illustrates, indicators cover the three pillars of sustainability, comprising the social, environmental and economic dimensions.

Moreover, all indicators satisfy the following criteria:

- **Relevance**: indicators must relate to the definition of a post-carbon city (see Section I) and cities should be able to influence the indicator value;
- **Clear Message**: indicators must have a clear target and direction and should be comprehensible both in terms of name and results;
- **Data Availability**: data for the indicators should be available on the city level;
- **Data Quality**: data for the indicators should be reliable.

Figure 1: Post-Carbon City Index



The social dimension investigates inter and intra-generational equity during the transition process. It highlights the benefits for inhabitants that arise through living in a city with reduced carbon emissions, giving special attention to standards of living, unemployment rates and poverty. Public services and infrastructures that are available for citizens as well as culturally valuable aspects of governance and civic society are further analysed.

The environment dimension is concerned with the ecological profile of the city. It assesses the current and upcoming impacts on the ecosystems and also evaluates the resilience of the city. The environmental dimension covers not only the final energy efficiency but also the energy sector in general, emphasising energy intensive sectors such as transportation/mobility and building stock. Other sub-dimensions considered are biodiversity, air quality, waste and water.

The economic dimension focuses on sustainable economic growth based on the wealth of the cities and their inhabitants. The labour market and the firms' wellbeing are taken into account as they demonstrate the dynamics of a post-carbon economy in a green economy paradigm. Public finances are also analysed since they help determine whether or not a city is prepared to face the challenges arising through its transition process. As no city can become post-carbon without innovation, R&D expenditure is also considered within this dimension.

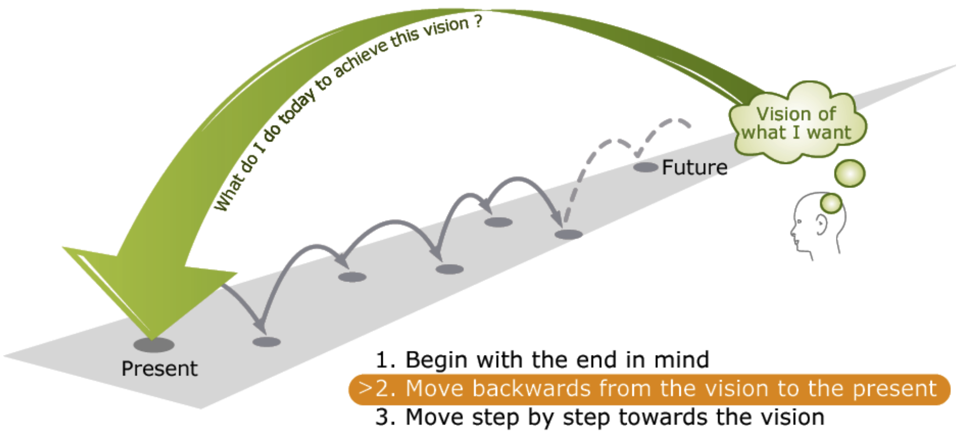
POCACITO acknowledges that cities are complex, adaptive, social-ecological systems and cannot be fully understood by examining individual components (Silva et al. 2014). For this reason, these three dimensions are not regarded as silos but combined by the PCI in a comprehensive and holistic approach.

II.II CASE STUDIES

The city case studies are at the heart of POCACITO. The cases were investigated in depth to assess the various challenges and opportunities of different city types and thereby selected to represent a wide range of possible city typologies, covering, e.g., different population sizes as well as geographic and topographic aspects.[1]

Within the case studies, the **visioning and backcasting approach** was chosen as the main tool. Different from other scenario techniques, visioning does not aim at generating descriptions of futures that are likely to happen but instead produces a fact-based potential future. The ensuing backcasting process then establishes how the vision can be attained. It is thus normative rather than explorative, "working backwards from a particular desired future end-point to the present in order to determine the physical feasibility of that future and what policy measures would be required to reach that point" (Robinson 1990, p. 283). For this reason, the work pertaining to each case study entailed two core elements: the building of a vision (representing the normative endpoint) and the strategic or backcasting scenario (drafting the procedure to reach the endpoint). Figure 2 provides a visual representation of the backcasting approach.

Figure 2: Visualising the backcasting process



[1] City typologies have been analysed extensively within the POCACITO project. A description of this analysis is provided in Section II.III of this booklet.

Source: The Natural Step 2014

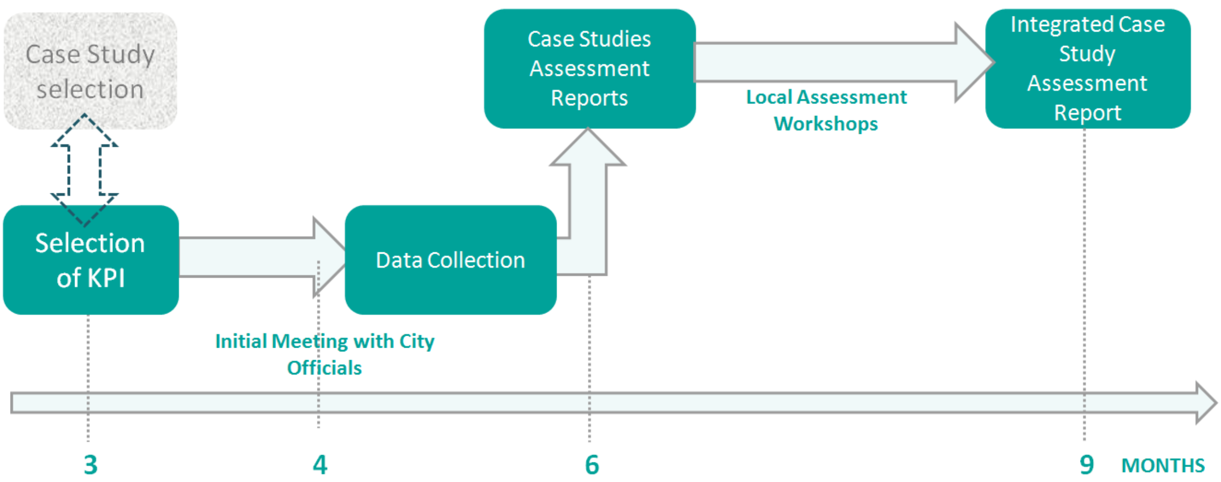
Each case study followed a five-step procedure, consisting of an initial assessment, vision building, backcasting exercises (scenario building and sensitivity analysis) and transition strategy development. After outlining the present state of the city within an initial assessment, creative brainstorming was employed to induce stakeholders to envision the future of their city and then develop qualitative scenarios describing how the transition to reach their post-carbon vision might be translated into single steps or actions. Obstacles and opportunities that might be encountered along the way were identified and, in particular, actions needed to meet future goals were highlighted.

Participatory workshops implemented the five steps in the case study cities.[2] These workshops created a **living lab environment** by bringing together stakeholders and scientists, enhancing innovation and yielding to a diversity of views, constraints and knowledge. The five different methodological steps are described chronologically and in more detail below.

1. INITIAL ASSESSMENT

The initial assessment of each case study city consisted of an extensive analysis of the current situation in order to identify key challenges and opportunities. Moreover, the assessment helped to establish city baseline or business-as-usual scenarios, which served as the foundations for subsequent activities. The initial assessment is done through the use of a common methodology and based on a participatory process. It includes the interrelated stages displayed in Figure 3.

Figure 3: Methodological Approach of the Initial Assessment



The KPIs help cities monitor their transition towards a post-carbon city, with indicators corresponding to the three sustainable development dimensions of environment, society and economy. Alongside the KPIs, data collection ensures the quality of future scenarios and the modelling of impacts. The selected methods for data gathering and collection involve the following two components:

[2] This common methodology allowed some degree of adaptation in order to account for the great diversity among the case study cities and accommodate their specific needs. See also page 9.

- **Bottom-up component** – discussions with local authorities and other selected stakeholders are used to complement the collection of quantitative data and enrich the contents of the case study assessment reports;
- **Top-down component** – completion of the indicators list (Post-Carbon City Index) according to a review of main statistical findings, existing relevant strategic and planning documents and legislation assured accurate quantitative data collection.

During a first initial assessment workshop, local stakeholders and scientists worked together to analyse the data collected for the KPIs and discussed the current stage of development of the respective city. The initial assessment findings for each case study city can be found in the Case Study City Initial Assessment Reports.

2. VISIONING

The workshop for the visioning exercise determined the desired endpoint of transformation for each post-carbon city. It was guided by the common POCACITO storyline, which was based on the socio-economic pathway (SSP) "SSP2" formulated in the context of the most recent IPCC Assessment report (Krey & Masera 2014). The SSP2 represents a "business as usual world", where present developments are assumed to continue as an extrapolation of recent decades.[3] The POCACITO project augmented the SSP2 by identifying external drivers that were considered relevant for the shaping of the local post-carbon visions and conditioning urban development and transformation policies.[4]

The visioning workshop held in each case study city consisted of two parts, starting with the presentation and discussion of the initial assessment results and proceeding with the vision building exercise. First, the results of the initial assessment of the city were presented in order to identify the key challenges the city is facing. To determine the desired endpoint of transformation, stakeholders were then divided into smaller groups and prompted to collectively draw images of their vision. This creative activity aimed at encouraging stakeholders to relax and be more expressive, facilitating disconnection from daily policy discourse and encouraging interaction in a less formal way. Furthermore, stakeholders reflected on the vision as members of the community first and only secondly as representatives of their organisations. The stakeholder groups then rotated between tables until each group had contributed to each drawing. Returning to their original place, stakeholders then summarised the drawings and organised their ideas using a mind map. The main themes were identified and the key messages were synthesised to develop a complete post-carbon vision.

3. QUALITATIVE SCENARIO BUILDING

Based on the initial assessment and vision exercises, stakeholders developed qualitative scenarios. These scenarios described how the transition to reach the respective post-carbon visions might be translated into single steps or actions. As described in depth by Johnson & Breil (2015), the qualitative scenarios consist of five key methodological steps:

[3] For more Information on SSP2, see Krey and Masera (2014) or Breil et al. (2014).

[4] For an overview of these drivers see Breil et al. (2014).

I. Definition of a normative “desired” endpoint (vision from the previous visioning workshop)

II. Consideration of scenario specific obstacles and opportunities in reaching the endpoint

III. Identification of milestones or interim projects that would signify progress in reaching the endpoint

IV. Definition of actions that must be taken to get to the endpoint

V. Validation of robustness of actions in the case of other background scenarios playing out

Using the 2050 post-carbon vision, stakeholders defined several endpoints that represented the main sectors and ideas proposed in the visioning workshop. For each normative endpoint, stakeholders wrote down on index cards the various obstacles and opportunities, milestones and interim projects that they anticipate encountering along the way towards the endpoint under a business-as-usual scenario (BAU). These index cards were then arranged on a timeline between now and 2050. Afterwards, stakeholders brainstormed concrete actions to reach interim and final goals and placed these on the timeline as well. This step included specific discussions on what has to be done, who needs to do it and when it has to happen. Finally, according to the methodology, actions identified to achieve the vision were checked for robustness, considering the local impacts from possible global socio-economic and environmental trends from now to 2050, i.e., based on the POCACITO storyline or background scenario. Due to different constraints, this final step could not be performed in any of the workshops. It thus represents an interesting springboard for further research.

4. QUANTIFICATION AND MODELLING PROCESS

The methods used for the quantification and modelling process are briefly summarised below. For a complete description of all quantification and modelling methods see Harris et al. (2015), Harris et al. (2016a) and Harris et al. (2016b).

During the workshops on the quantification of impacts and modelling, the Sensitivity Model (SM) developed and described in Vester (2004) was adopted in order to understand the interdependencies between different variables in each city’s urban metabolism and hence to identify specific key factors for the individual case study cities. The SM was chosen for three reasons. First, it constitutes a systems dynamic approach, which facilitates an understanding of the complex interactions between factors within a city. Second, it does not require “precise/exact” data inputs but rather works by modelling the influences of variables on one another, making it a semi-quantitative modelling tool. Third, it is highly applicable since, like the POCACITO project, it is based on a participatory approach.

In order to better reflect the use of the model and make it more marketable to the city stakeholders, the approach was adapted, utilised and renamed POCACITO Critical Influences Assessment (PCIA).[5] The main difference between the original approach and the PCIA is that the previous POCACITO workshops were incorporated as an initial impact matrix and analysis before the quantification workshop took place. Thus, some of the more laborious work from the workshop participants was removed, resulting in more time for review, discussion and refinement. The eventually carried out

[5] For a complete description of the original SM see Vester (2004).

PCIA approach consisted of the following three steps:

I. System description and variable set

II. Constructing the impact matrix

III. Analysis of the variables from the impact matrix and other tools

The system description gives a holistic overview of the city in question. It is particularly helpful in describing the boundaries of the urban metabolism, which is done using the information and descriptions gathered by the initial assessment.

The impact matrix maps the interdependencies of the variables. For the POCACITO case studies, the case study research team developed these matrices, using the information gathered in the previous workshops on visioning and scenarios, thus reducing repetitive work for the stakeholder participants who then only had to review and verify the matrix in the PCIA workshops.

After completing the matrix, an Excel based tool supported the quantification.[6] This tool sums across each row and column to produce an "active" and "passive" score for each variable and thereby identifies specific critical influences for the individual city. Local stakeholders in each case study city were discussed and verified the validity of this PCIA analysis.

Following the PCIA process, two scenarios were developed: the BAU and the PC2050. The BAU scenario is projected from current trends, which are derived from Selada et al. (2015) and can be understood as a baseline for the BAU scenario. Where appropriate, the BAU considers progress made in relevant ongoing and planned projects. The PC2050 builds on the qualitative scenarios described earlier in this section and developed in Breil et al. (2015). It is thus an interpretation and expansion of the visions, actions and milestones. Table 1 provides an overview of the calculation approach for each of the main elements for quantifying the PC2050 scenarios.

Table 1: Overview of Calculation Approach

ELEMENT	BRIEF DESCRIPTION OF CALCULATION METHOD
Population	Population projections were based on data obtained from Oxford Economics and other data from literature. For the difference between BAU and PC2050, we utilised data from the Shared Socio-economic Pathways (SSP's) of the International Institute for Applied Systems Analysis (IIASA 2015).
Energy	Energy use and production used a range of data available from various sources to determine trends for each city. In general, we established a current trend and projected BAU using assumptions on changes in the key influence factors including population change, transport, residential sector, business and industry. The key document for providing a background reference scenario for BAU national energy use and production is the report for the European Commission, "EU Energy, Transport and GHG Emissions. Trends to 2050" (Capros et al. 2014). PC2050 was determined based on an interpretation of the post-carbon scenarios and the associated actions and milestones.
Transport	Various sources were used. Data on total energy used by the transport sector and the modal share breakdown and trends was obtained from the POCACITO report "Integrated Assessment Report" (Selada et al. 2015). Assumptions are outlined in Annex 2 of Harris et al. (2015) and are based on the current trends for BAU and an interpretation of the degree of sustainable transport and the modal share for PC2050.

[6] For a detailed description of both PCIA and impact matrix analysis, see Harris et al (2015).

ELEMENT	BRIEF DESCRIPTION OF CALCULATION METHOD
Housing and building	In most cases, trends for the residential and service sectors were used as a background to projecting the expected energy use of housing and buildings. This was adjusted depending on other qualitative information, such as projects and policies for energy efficiency etc. For PC2050 an interpretation of the energy efficiency measures and other actions were considered.
GDP	GDP was calculated from the trends provided by Selada et al. (2015) and supplementary data where required. In addition, the data projections were obtained from Oxford Economics.
Business and Industry	Information on the industry mix and employment was highly variable; it was very good in some cases and sparse in others. Current trends were generally projected to 2050 with some moderation due to expected limits to the trends (i.e. an expected ceiling to the growth of the service sector).

Source: Harris et al. 2015

As a next step, the impacts of the PC2050 scenarios are compared to the BAU outcomes across all three dimensions of POCACITO: environment, social and economic.

The impacts methodology consists of the following four main components:

I. KPI assessment and qualitative analysis
II. Quantitative analysis
   a. Energy and GHG
   b. Environmental footprint (using EE-MRIO)
III. Eco-system services
   a. Spatial modelling of city development for 2050
   b. Recreational benefits from urban green areas (only for Copenhagen and Malmö)
IV. Socio – economic assessment
   a. Investment costs
   b. Cost-benefit analysis

The Key Performance Indicator (KPI) applies the POCACITO KPIs (Selada et al. 2014) to derive a semi-quantitative assessment of the expected change for each indicator under both of the scenarios.

The quantitative analysis consists of two steps. First, energy use and resulting direct GHG emissions are projected to occur under the scenarios using emissions factors. Second, the indirect footprint of the human activities in the cities including consumption is calculated using the Multi-Region Input Output (MRIO) methodology[7] and the EXIOBASE[8] database, assuming that the city footprint can be calculated from final demand of household consumption and government expenditure.

The potential impacts caused by urban sprawl and changes in land use are quantified by modelling a continuation of the recent trends.

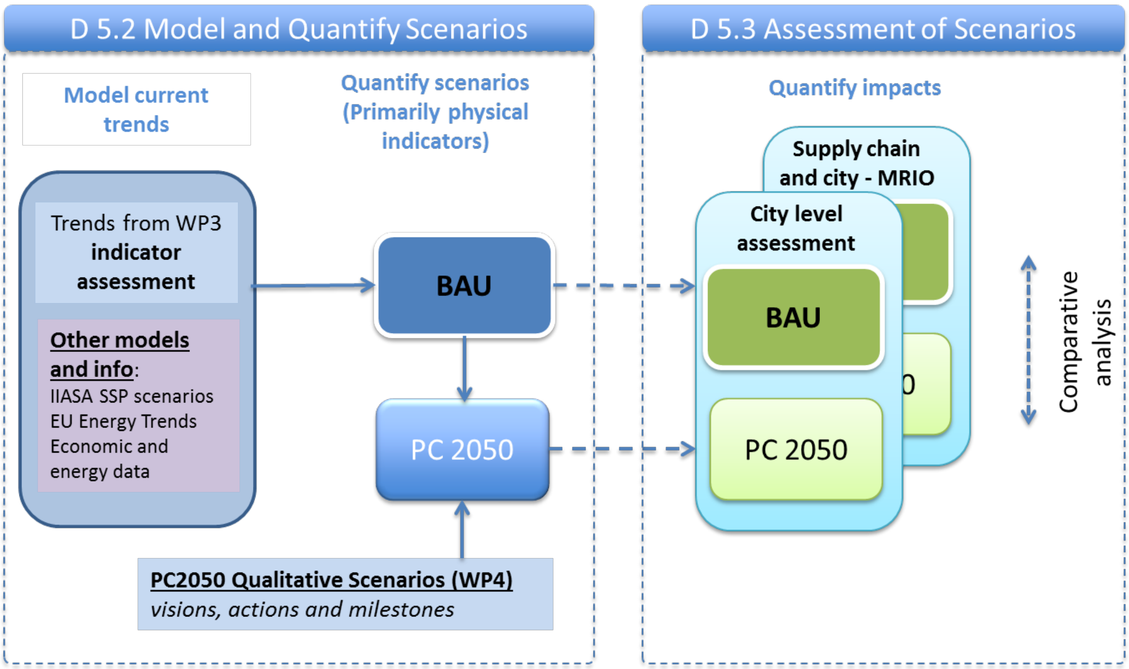
For the Copenhagen and Malmö case studies, the recreational benefits provided by urban green areas are assessed. Due to limitations in data availability and the project scope, this was only conducted for these two cities.

[7] http://www.oneplaneteconomynetwork.org/timeline/mrio-database.html

[8] http://www.exiobase.eu

Finally, a further socio-economic assessment compares the investment costs and potential benefits of BAU and PC2050.

Figure 4: Modelling and quantification processes within WP5



5. ROADMAP BUILDING

The fifth and last local workshop discussed the impacts of the initial set of measures and identified additional actions necessary to close the gap towards the local 2050 post-carbon vision. It thereby provided additional input for the local strategy papers and for the EU 2050 Roadmap, which are two of the core outcomes of the project. The roadmap workshop helped integrate the work done on the local level into the EU 2050 Roadmap.

CHALLENGES IN AND DIFFERENCES BETWEEN CASE STUDIES

The common methodology described above was applied with some variations in all cities. Challenges occurred especially regarding the quantification and modelling processes, as not all data required was available in every case study city. Moreover, adaptation was needed either because the local political situation did not allow for extensive stakeholder participation (in Lisbon a combination of interviews and a small workshop was chosen) or because the approach to creative brainstorming—asking participants to draw pictures of their vision—was deemed unsuitable for some types of stakeholders (Barcelona, Istanbul). In order to create efficiency gains and given the closeness in both framework and geographic conditions, joint workshops were organised for the case study cities Torino and Milan. In the case study city of Copenhagen, workshops were replaced with interviews as the city could not commit to the full POCACITO process. Instead, an existing post-carbon vision was used.

II.III GLOBAL INVOLVEMENT

As POCACITO recognises the benefits of mutual learning at a regional and global level, the project interacted with several partner countries globally and developed a platform to facilitate a reciprocal dialogue and knowledge exchange on urban best practices between stakeholders. This platform consists of the Inventory of Urban Sustainability Initiatives and a Marketplace of Ideas. Furthermore, the project pursued additional methods of sharing and exporting know-how globally, such as webinars and study tours.

INVENTORY OF URBAN SUSTAINABILITY INITIATIVES

The Inventory of Urban Sustainability Initiatives covers Europe and other countries around the world. It was developed to improve the knowledge base on successful city transition strategies and at the same time foster debates and mutual learning. The inventory is composed of three parts: An Inventory of Leading Cities (Beveridge et al. 2014), an Inventory of Good City Practices (Döhler et al. 2014) and an Inventory of Good National and EU Practices (Beveridge & Döhler 2015).

The Inventory of Leading Cities was developed to better contextualise the notion of "leading" in relation to cities (as well as practices) and to identify similarities among cities with respect to what is conducive for a transition to a "post-carbon" state. The following four methodological steps were applied to develop the Inventory of Leading Cities:

I. **State of the art**: This step was an initial gathering of data on the level and quality of action in cities. The collected data focussed to a large extend on post-carbon initiatives in cities across the globe.

II. **Expert survey**: In this step, we asked 25 experts in urban climate and energy policy and planning from academic, policy and practice backgrounds to nominate cities they considered "leading" the post-carbon transition and to provide brief explanations as to why.

III. **Multi-dimensional matrices**: The third step was feeding the data into multi-dimensional matrices and applying filter criteria to produce leading cities lists according to performance criteria and level of activity.[9] These were then grouped according to context variables: urban population, economic development and climate and energy.

IV. **Develop Criteria**: In the last step, we developed criteria to select leading cities according to performance and action.

The Inventory of Good City Practices builds upon the Inventory of Leading Cities. It identifies and collects basic information on 100 good city practices within the leading cities. This includes three types of best/good practices, i.e.:

I. Comprehensive city-wide strategies, such as master plans and sustainability strategies for the whole city or city-region which may include long-term strategies and visions;

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[9] POCACITOs leading cities were chosen according to the following criteria: minimum three memberships in initiatives (e.g. Energy Cities) or nomination in city rankings (e.g. Green City Index) or minimum one expert survey nomination and approved Covenant of Mayors (COM) Sustainable Energy Action Plan (SEAP) or European Energy Award (EEA) or minimum two expert survey nominations. For more information on leading cities see Beveridge et al. (2014).

II. Demonstration and pilot projects that aim to transform specific neighbourhoods, including initiatives for different types of neighbourhoods;

III. Sectoral policy initiatives such as the introduction of congestion charges or the strategic development of bike lanes in the transport sector, including the most important policy areas such as energy, transport, food, green space, etc.

The Inventory of Good National and EU Practices completes the overarching Inventory of Sustainability Initiatives. In line with the Inventory of Good City Practices, its methodology is qualitative and descriptive. Material for the Inventory of Good National and EU Practices was collected from scientific literature, particularly on multi-level interactions in local post-carbon, energy and sustainability transition processes. It provides some emblematic examples of good EU and national practices and takes into account the findings from both the Inventory of Leading Cities and the Inventory of Good City Practices.

All in all, the Inventory of Urban Sustainability Initiatives provides insight into some of the key EU and national practices as well as preliminary conceptual thinking on the topic. However, it does not offer the depth of empirical material necessary to make substantive claims about the effects of EU and national practices.

TYPOLOGY OF CITIES

The Typology of Cities report developed by Beveridge et al. (2015) can be considered a first step in closing the research gap regarding the diversity of urban transitions, particularly on how contextual factors (e.g. regarding the economic state, population size and climate) shape actions and performance within cities. On the basis of the Inventory of Urban Sustainability Initiatives, the Typology of Cities identifies indicative examples of urban sustainability transitions per mid-sized city type and develops a preliminary non-comprehensive typology.

Due to the challenge of acquiring comparable data on cities' environmental performance, the approach is in large part explorative and qualitative. The cities are profiled in terms of their contexts of action, basic strategy and main achievements. From this, the purpose of the typology is to provide a basic structure for analysing urban sustainability transitions: to help identify commonalities and differences across urban contexts. This identification is of special importance for disseminating and scaling up effective practices across European cities under different contextual conditions and with limited funding.

MARKETPLACE OF IDEAS

The Marketplace of Ideas aims to reach stakeholders worldwide. It provides easily consumable information and resources that expand the reach of individual partners. Beyond this multi-pronged municipal actor outreach approach, the project's city network connects European municipalities and thus fosters integration and cohesion. Even greater leverage of innovative information exchange and knowledge entrepreneurship is created by incorporating non-EU city partners as contributors and at the same time as recipients of "Online Marketplace" information. The mechanics of the "Online Marketplace" thus establish a permanently growing database of sustainable urban planning and governance information.

OTHER WAYS TO SHARE AND EXPORT KNOWLEDGE

Best practices identified within the project were additionally exchanged by means of workshops, study tours and several web-based tools. Innovative solutions are also spread to non-EU emerging cities via a web-based knowledge platform. Moreover, a closer cooperation was established with two cities in China and Brazil. The knowledge exchange goes beyond the exchange of technological options and also assesses the dynamics cities can have in developing low-carbon resource efficient solutions.

III TOWARDS AN EU ROADMAP FOR POST-CARBON CITIES

III.I INVENTORY OF URBAN SUSTAINABILITY INITIATIVES

LEADING CITIES INVENTORY

Within the Inventory of Leading Cities, 94 European cities were identified and both basic information and data was gathered to show their progress with respect to development towards post-carbon futures. A great diversity of cities emerged, as the leading cities vary markedly in size—the largest being London (approx. 8.3 million) and the smallest, Großschönau, Austria (approx. 1,200). Moreover, there are extremely wealthy cities, such as Basel (GDP/cap in PPS: €127,365) and much poorer cities, such as Skopje (GDP/cap in PPS: €9,000). There is also a wide variation in climate and energy use in terms of heating days, from Oula in Finland (6142 days in 2000-2009) to Oeiras and Cascais in Portugal (833 days in 2000-2009). To provide a snapshot of the List of Leading Cities, a condensed version of it is provided in Table 2. For a complete list see Beveridge et al. (2014).

Table 2: Examples of Leading Cities, Listed in Descending Order of Population Size

Leading city	Country	Population	Regional GDP/cap in PPS	Average heating-degree days 2000-2009	Memberships in initiatives and rankings
London	United Kingdom	8.308.369	80.400	2.477	3
Barcelona	Spain	1.611.822	28.400	1.826	4
München	Germany	1.388.308	42.200	3.198	4
Brussels	Belgium	1.140.000	55.600	2.452	4
Stockholm	Sweden	897.700	43.300	3.882	5
Tampere	Finland	220.446	26.300	4.879	5
Jeseník	Czech Republic	11.600	16.500	3.356	2
Judenburg	Austria	10.130	28.100	3.428	3
Hlinsko	Czech Republic	9.900	16.700	3.407	2

Population classification

(no fill)	0	5.000
	5.000	50.000
	50.000	100.000
	100.000	250.000
	250.000	500.000
	500.000	1.000.000
	1.000.000	5.000.000
	5.000.000	20.000.000

GDP/CAP in € PPS classification

(no fill)	#N/A (No value)	
	10.000	20.000
	20.000	30.000
	30.000	40.000
	40.000	50.000
	50.000	60.000
	60.000	70.000
	70.000	150.000

Heating degree days per year (EEA) classification

(no fill)	#N/A (No value)	
	1	1.000
	1.000	2.000
	2.000	3.000
	3.000	4.000
	4.000	5.000
	5.000	6.000
	6.000	20.000

Not all of the 94 chosen cities can be considered European leaders per se, but every city was selected for a combination of specific reasons (e.g. city network membership, rankings, expert opinion, EEA certification, and Covenant of Mayors SEAP approval). For example, cities such as Jeseník (Czech Republic) or Tuzla (Bosnia and Herzegovina) can be seen as leading at least in their national or regional contexts, even if their performance is not comparable to well-known European leaders such as Barcelona or Copenhagen. Their inclusion should assist with developing a more contextualized understanding of good practices, allowing us to see which practices have been implemented in different types of cities.

The aim of this list has been to shift the focus from thinking in terms of the “number 1” or the “top ten” and a competition between the usual suspects, to a more inclusive reflection on the broader spectrum of urban post-carbon transitions activities found in cities. The approach also sought to give better consideration to the different contexts of action as well as the constraint and opportunity structures in which cities find themselves.

GOOD NATIONAL AND EU PRACTICES

The Inventory of Good National Practices analysed examples of good EU and national practices. A consistent finding is that EU and national initiatives can create conducive frameworks, which can ultimately motivate cities to adopt local climate strategies or, through funding and advisory support, provide effective support in their implementation. However, centralised or top-down enforcements of local climate action remain the exception. Even in the UK, where a centralized approach exists, local agency plays an important role in the successful implementation of climate policies.

Horizontal initiatives are both effective and increasingly apparent in Europe, but their compliance is never guaranteed and questions remain as to how less advanced cities can be encouraged to become active members. In contrast, it is the case that many networks tend to be most effective for cities that are already relatively advanced. Even though constraints are often related to a particular combination of capacity deficits (e.g. lack of finances, social capital, political disagreement), and hence cannot easily be ‘solved’ from the outside, higher multi-national policy support for less developed cities might be needed to encourage them.

The Inventory of Good National and EU Practices concludes that there is no form of governance (be that hierarchical, vertical or horizontal) that is more effective than others. Instead, a combination of good practices at different levels is likely needed for the transformation of society.

III.II INITIAL ASSESSMENT OF CASE STUDY CITIES

The evaluation and comparison of the pre-defined KPIs in the case study cities suggest that there is a general trend towards a post-carbon paradigm. However, the results of the initial assessment show that currently cities are located at different development stages. A brief summary of these results is given below.

Barcelona can be considered at the forefront of the smart cities movement. The metropolitan area has implemented several strategies that promote a post-carbon transition in the areas of energy, mobility, water and waste management and biodiversity. Along with these strategies, smart technologies are already widely used. Unemployment and poverty remain areas of concern and need to be addressed further in the future.

Istanbul's environmental performance is not only the weakest dimension of the city, it is also the most underestimated one by the stakeholders. Major problems are growing urbanisation, urban sprawl, pollution and stress in natural protection areas. However, Istanbul has improved remarkably in economic and social terms.

Lisbon has launched several strategies and projects in the areas of energy, mobility and biodiversity but the impacts are still limited. Unemployment and poverty risks are increasing due to the economic and financial crisis.

Litoměřice is a small city that is influenced by the development of higher territorial units. The geothermal power plant future project demonstrates the city's ambition to become self-sufficient in energy matters, but Litoměřice is lacking further projects or strategies needed to lead the transformation to become "post-carbon" by 2050.

Malmö implemented an ambitious energy strategy, bringing along positive impacts in carbon emissions and energy consumption. It is a young and multicultural city with reasonable economic and social performance.

Milan is a leading city in economic terms, but the investment in environmental issues is comparatively low. Pollution and poor air quality are two of Milan's most urgent concerns.

Turin shares Milan's problems of pollution and air quality. It is an innovative city, but due to strong specialisation, it is being affected by unemployment and poverty.

Rostock adopted important measures to reduce its environmental footprint. Strategies and projects are implemented in the areas of air quality, waste and water management as well as sustainable mobility and have delivered positive impacts.

Zagreb's population is highly qualified in academic terms and there are some grassroots movements in place. However, a large weakness is present through the lack of long-term initiatives and projects.

III.III LOCAL STRATEGY PAPERS

This section discusses the most essential outcomes of the local strategy papers. These documents are the result of the inclusive methodological approach discussed in Section II.II of this booklet. Therefore, the local strategy papers are influenced by both expert research and stakeholder visions.

KEY PERFORMANCE INDICATOR ANALYSIS

The KPI analysis finds good overall performances in most case study cities across the categories for both scenarios. Most cities perform especially well in environmental and energy related indicators. Only Istanbul faces the risk of vastly increasing GHG emissions due to a large increase in population, affluence, associated energy use and limited progress in renewable energy.

Besides these good overall performances, there is a clear difference between BAU and PC2050. In BAU, most cities only provide "likely positive" progress meaning that the general direction is positive, but progress is likely to be too slow to achieve the post-carbon status by 2050.

In the PC2050 visions and scenarios there was a gap for most cities in regards to some environmental factors such as waste recovery. This partly reflects the methodology used in the research, which allowed only for both a limited number of workshops and limited revisions of the actions and milestones associated with the scenarios.

The poverty level is a key area of concern for several cities, especially for Litoměřice, Milan, Rostock and Turin where the projected progress is likely negative under BAU and either negative or not visible under PC2050. Progress within the majority of remaining cities is projected to be slightly positive under PC2050. Istanbul is the only case study city expected to have significantly positive developments in this regard.

ENERGY AND GHG EMISSIONS

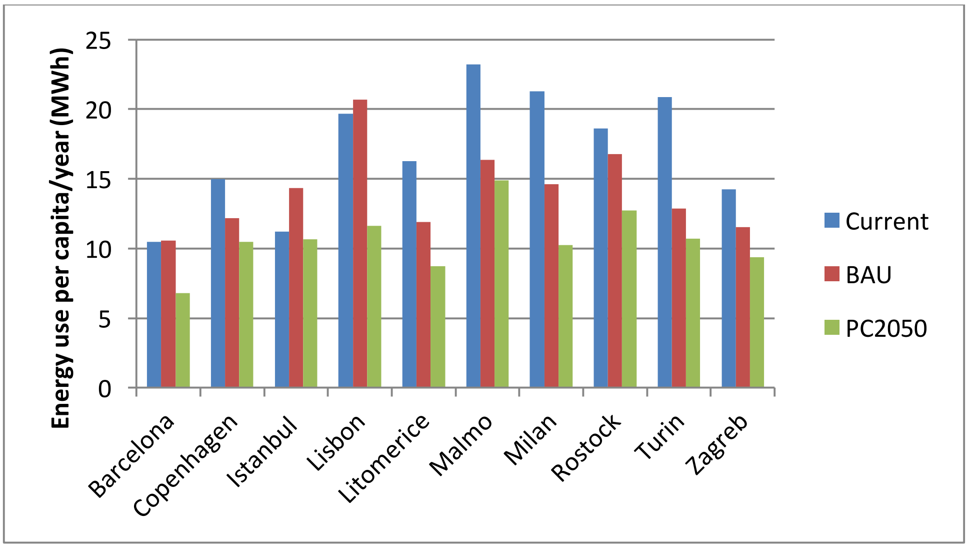
The scenarios for energy and GHG emissions are developed with the standard territorial method and with the footprint analysis. The standard territorial method considers only direct emissions from energy use and production. In contrast, the footprint analysis takes into account the supply chains of products consumed within the cities. It defines the environmental footprint of a city as all products finally consumed within the city by the citizens.[10] The first part of this section focuses on the results from the standard territorial method. The second part will compare these results with the results of the footprint analysis.

THE STANDARD TERRITORIAL METHOD

The analysis of energy use per capita shows a decline for eight of the ten case study cities in the BAU and for all of the case study cities in the PC2050 scenario. The only exceptions in the BAU are Lisbon and Istanbul. While this suggests that developments generally head in the right direction, the current use of energy per capita/year highlights room for energy efficiency improvements in the majority of cities. The average among all cities is around 10 MWh of energy per capita/year, with Barcelona being at the lower end of the range with 6.8 MWh per capita/year.

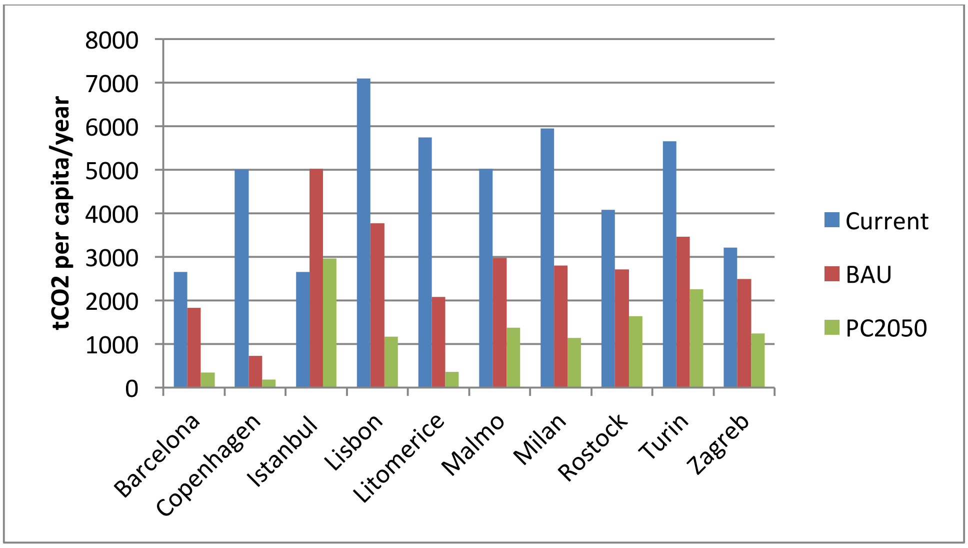
[10] For information on the quantification of city footprints see Harris et al. (2016b).

Figure 5: Energy Use Per Capita Currently Compared to BAU and PC2050



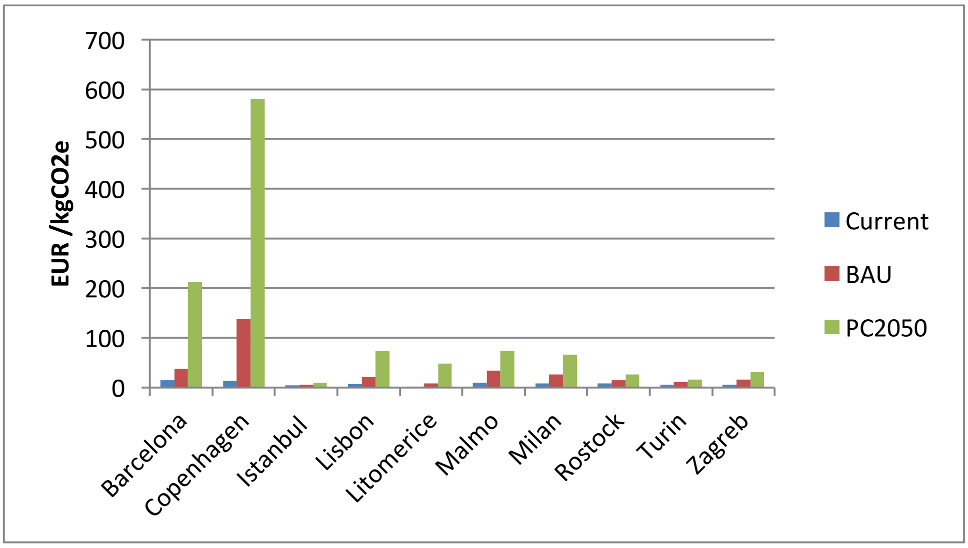
The analysis of current GHG emissions per capita shows diverse levels, ranging from 2.6 tCO_2e per capita/year in Barcelona to over 7.2 tCO_2e per capita/year in Lisbon. Alongside Copenhagen and Litoměřice, Barcelona also secures the lowest numbers in PC2050 and in BAU. Lisbon improves remarkably in both scenarios, handing over the highest number of GHG emissions per capita to Istanbul. Istanbul is also the only city that shows a negative trend. With its large increase in population, affluence, associated energy use and limited progress in renewable energy, Istanbul faces the risk of vastly increasing its GHG emissions in the coming years. The decreases for all other cities are significant. Emissions are lower under PC2050 compared to BAU, ranging from 60% for Rostock and Turin to up to 96% for Copenhagen. The largest differences between the BAU and the PC2050 scenario can be observed in Copenhagen and Litoměřice, which suggests that they developed the most ambitious PC2050 scenarios.

Figure 6: GHG Emissions Per Capita



Looking at the current economic output per unit of GHG emissions, Barcelona and Copenhagen are again the best performers, creating more than 10 EUR of economic output per kgCO_2e. Litoměřice is located at the other side of the spectrum, producing only slightly more than 2 EUR/kgCO_2e. All other cities find themselves between 3 and 9 EUR/kgCO_2e. An important fact is that all cities improve remarkably under both BAU and PC2050, which implies a decoupling of GHG emissions from economic output. In PC2050, the best performers again appear to be Copenhagen and Barcelona, with Copenhagen generating 581 EUR/ kgCO_2e.

Figure 7: GDP (EUR) Created for Each kg of GHG Emission



FOOTPRINT ANALYSIS

The results of the footprint analysis for GHG emissions per capita differ strongly in comparison to the territorial calculations. As discussed above, GHG emissions on a per capita basis decrease for the majority of cities under both BAU and PC2050 (but most dramatically under PC2050) when measured with the standard territorial method. In comparison, Figure 8 shows that the total GHG emissions per capita (direct + upstream) increase for eight of the ten cities under BAU and PC2050 when measured with the footprint analysis, a result that can be accounted for by upstream emissions. Under PC2050, this increase ranges from 234% in Istanbul to 16% in Copenhagen. Only Milan and Turin manage a slight decrease in BAU and PC2050 compared to the base year emissions. This is likely linked to more modest increases in GDP per capita for these cities, but it may also be due to limitations of the modelling.

Figure 8: Direct and Indirect GHG Emissions for all Case Study Cities for 2007, BAU and PC2050

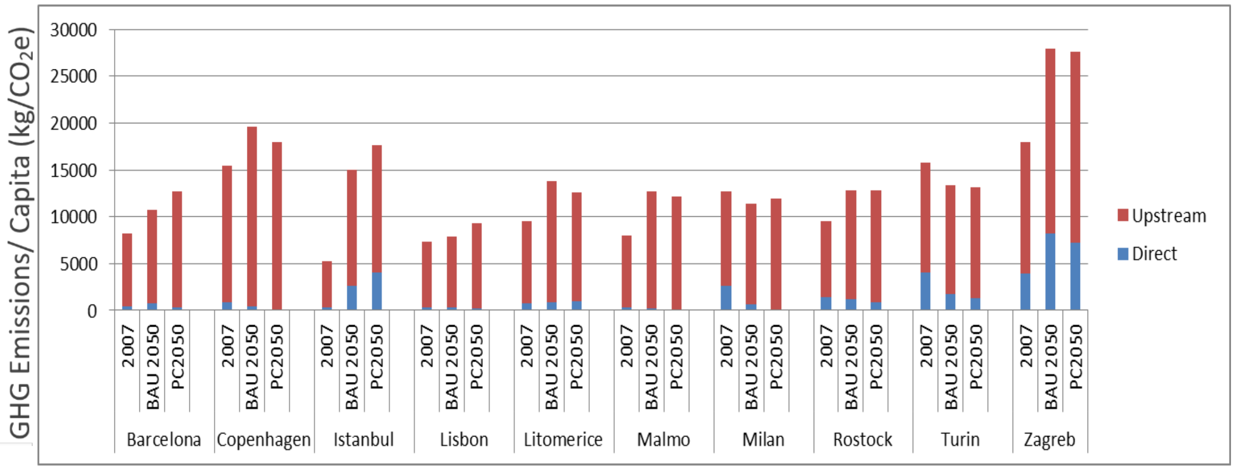


Figure 9 and Figure 10 depict the change in GHG emissions per capita in BAU and PC2050 compared to the base year. Figure 9 shows the percentage change calculated with the standard territorial method and Figure 10 shows the percentage change with the footprint analysis. A comparison between the two figures again highlights the differences arising through the use of the two different calculation methods.

From these results one can conclude that the calculating method is very decisive. Moreover, they show that if the quantification method includes indirect emissions, all case study cities run a high risk of missing their 2050 vision of becoming post-carbon city.

Figure 9: Percentage Change in GHG Emissions Per Capita from 2007 to BAU and PC2050 Using Standard Territorial Calculation Method

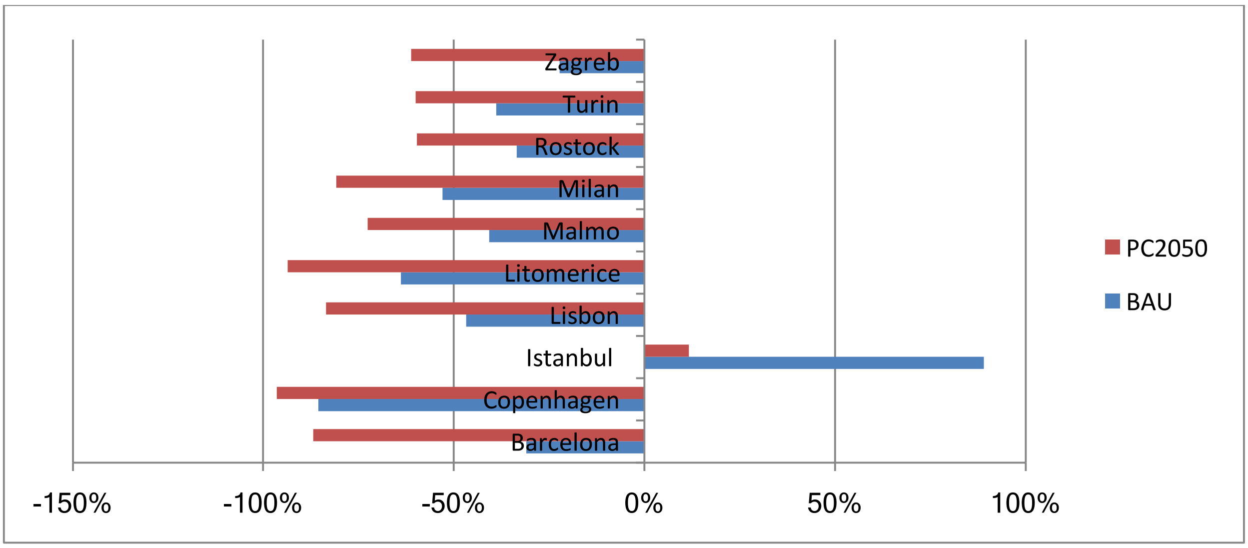
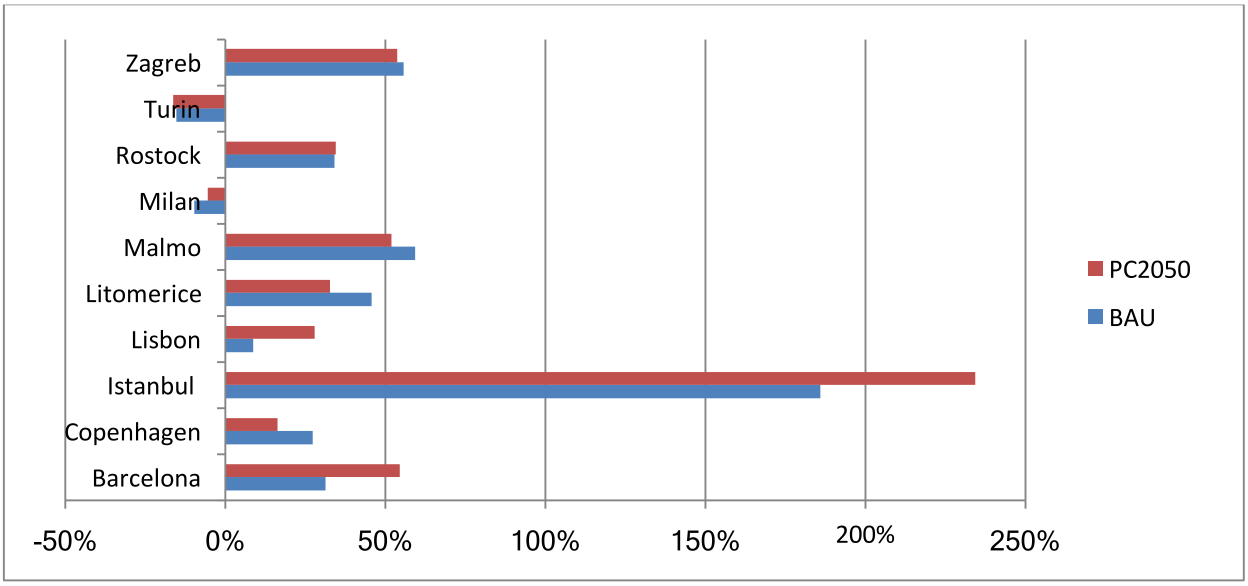


Figure 10: Percentage Change in GHG Emissions Per Capita from Base Year to BAU and PC2050 Using Footprint Analysis



LAND USE CHANGE

The analysis of land use change delivers significantly differing results for the BAU and PC2050 scenarios. This is to a large part triggered by the different assumptions taken within the scenarios. Whilst the BAU scenarios are modelled by extrapolating the 2000-2012 development trends, the PC2050 scenarios assume that policies ensure no net further development of non-urban land. Hence, densification is a central policy for the PC2050 scenarios.

The BAU results are of high interest as they illustrate the potential impact and encroachment of future developments on non-urban land. Despite some cities experiencing population decline, all cities will experience development of currently non-urban area if current trends continue. The cities with the highest potential for further loss of non-urban land, ranging from 43.7% to 19.9%, are Malmö, Istanbul, Copenhagen and Barcelona. This is of concern for two primary reasons. First, changes in land use may threaten green recreational areas and non-urban land, which are increasingly recognised by research as important for health, well-being and quality of life. Second, research also shows that sprawling cities require more infrastructure (and are therefore more resource intensive), are less energy efficient and have a higher carbon footprint than dense city areas.

SOCIO-ECONOMIC ANALYSIS

The socio-economic analysis shows a positive benefit-cost ratio for the majority of case study cities in the current situation; only Copenhagen, Istanbul and Malmö face negative values. This benefit-cost ratio is even more positive under PC2050, where it is positive for all cities apart from Istanbul (due to poor air quality). In PC2050, the ratio ranges from 0.6 to 6.4, the highest numbers belonging to the cities of Zagreb, Barcelona, Milan and Litoměřice. However, direct comparisons of the different cities cannot be made as the range of costs for PC2050 is related to both the size of the city and the degree of actions stipulated in the city visions (which were used as a basis for the modelling).

Although the socio-economic analysis utilises a simplified analysis of costs and benefits, i.e., the only benefits covered in the analysis are based on changes in air-quality and premature deaths, it still shows that the return on costs for a post-carbon transition is very positive for most cities.

FINAL CONCLUSIONS ON LOCAL STRATEGY PAPERS

The analysis performed by the POCACITO project concludes that a post-carbon status will not be reached by 2050 for the majority of case study cities under the current BAU trajectories. Only Copenhagen is expected to reach a level of under 1 tonne CO2e per capita/year. Istanbul falls on the upper end of the spectrum, reaching a level of up to 5 tonnes CO2e per capita/year and all remaining cities are in the range of 2-4 tonnes CO2e per capita/year. Due to weak actions and milestones, most of the case study cities will miss the post-carbon status even under the PC2050 scenarios.

Cities are the drivers of economic growth, but they are at the same time the root cause of the majority of consumption. Hence, there is a key role for cities to limit their footprint impact by fostering and promoting the circular economy. There are many ways in which a city can help foster a circular economy, such as by providing the facilities and infrastructure required to reuse, repurpose, refurbish, and remanufacture as well as the more traditional (but as yet not perfected or fully implemented) recycling. Cities have the opportunity to work together with businesses to enable this, but they can also help foster new innovative businesses through appropriate policies.

Analysis also suggests that the benefits of achieving the post-carbon status far outweigh the potential costs in most cases if effective and ambitious long-term strategies are implemented immediately, especially for energy efficiency and renewable energies. Despite being simplified, our analysis shows that the benefit-cost ratio is positive in nine out of ten cities (although an improved PC2050 strategy for the remaining city, Istanbul, would also make this value positive). Additionally, energy costs are significantly lower (by up to 45% for Lisbon) under PC2050 due to the increased emphasis on energy efficiency measures and the corresponding decrease in required capacity. Furthermore, thousands of jobs related to the energy efficiency and renewable energy provisions could be created by the PC2050 measures. In particular, the field of energy efficiency brings along significant opportunities to improve the measures of the PC2050 for most cities. However, the only way this could be realised is to embed an energy efficiency approach in policy to foster concerted action on transport, buildings, appliances and the planning of infrastructure. Finally, a lower energy demand would subsequently reduce the requirements for installed capacity of renewable energy and its storage.

Major concerns for all cities are the consequences of land use change and social disparity. This also holds for those cities with a projected population decrease and up to 43% of non-urban land being converted to urban land. One of the most important common KPIs with a poor performance in 2050 is the poverty level and the disparity between rich and poor. Such social issues certainly need to be highlighted.

III.IV 2050 EU ROADMAP

The POCACITO 2050 EU Roadmap is directed at national and EU policymakers and is as such intrinsically different than the local strategy papers, which present a city development strategy. Most important, the Roadmap describes lessons learned and actions required in order to transform a city into a post-carbon city.

Focussing on key lessons learned the EU 2050 Roadmap finds that both the visioning and backcasting exercises are highly successful in raising awareness of the need to act today. Moreover, these exercises increase the understanding of stakeholders of the diverging long-term views of other citizens, helping to build a consensus on long-term objectives and facilitate the task of identifying the necessary regulatory and financial conditions that would enable the city to change.

A key finding concerning stakeholder involvement is that a heterogeneous group of socio-economic actors needs to be ensured; otherwise the strategy developed is likely affected and/or biased by non-majoritarian interests. This needs to be considered upfront.

The Roadmap furthermore finds that if the planned actions of a city are too weak to reach a specific goal quantitative studies can be used to encourage further action by the stakeholders as they enable to assess the impact of political decisions on decarbonisation.

Next to these findings, the Roadmap provides a variety of key policy recommendations:

I. Cities need to have an integrated approach to city management and planning that is in line with long-term objectives.

II. Support to capacity building should be provided. This could be done through initiatives, such as the Covenant of Mayors. Moreover, a database of best practices globally should be set up.

III. Stakeholder-driven visioning and backcasting should be applied when designing strategies for a city. This increases the acceptance and understanding of city stakeholders about necessary changes.

IV. City infrastructures and services should be open, inclusive and affordable for citizens.

V. Cities need to be re-naturalised and more localised.

VI. National and EU strategies should to be drafted with the help and engagement of city representatives.

VII. The EU should support the process of reallocating competences, in line with the subsidiarity principle, in order to adequately face the challenges that cities face.

VIII. The EU should provide clearer and more stringent requirements for energy efficiency while furthering the implementation of circular economy action.

IX. Good statistics at the city level are required to be able to analyse the needs and benchmark cities.

X. More research on the interplay between climate, energy policies and local development should be supported.

XI. School education needs to place more emphasis on environmental sustainability.

XII. International collaboration between cities should be increased. This can be done through the use of the KPIs developed by the POCACITO project.

IV ROAD AHEAD

The POCACITO project addressed the significant challenges local stakeholders face when aiming to transform their cities into zero emission or post-carbon areas while at the same time dealing with both social and economical difficulties. The project developed strategies the on local, regional and international level and at the same time identified areas for further research.

In combination with basic information and city level data, the KPIs that were developed in the initial phase of POCACITO enabled the analysis of the current stage of development of cities. Since this analysis provided the basis for all following methodological steps, it proved very useful for the eventually produced local strategies and for the 2050 EU Roadmap. However, a broader database would have led to even more robust results. In this regard, the NACE 3 level provides a good background for data collections. Unfortunately, not all cities correspond to NACE 3 level cells, which hampers the possibilities to analyse and compare the different cases. A broader provision of NACE 3 level data is therefore in the interest of policymakers from local to regional (EU) levels.

Looking ahead, the development of a tool for lump sum analysis of city level data could prove useful, as it has the potential to considerably simplify and thus improve the quantification of data. Moreover, there is high potential to exploit the data and information gathered within the Inventory of Leading Cities. A further step would be to begin validating the POCACITO results by comparing them more vigorously with particular ranking schemes, especially those with stronger and more transparent methodologies like the Siemens Green City Index.

Finally, different POCACITO analyses identified the impacts of geographical definitions on city performances. In fact, the standard territorial calculation method, which focuses narrowly on direct emissions, delivers significantly differing results in comparison to the footprint analysis, which includes the indirect emissions of a city (and hence the surrounding region). As including the indirect emissions gives a more holistic picture of a city’s environmental impact, it may be desirable to shift from “post-carbon cities” to “post-carbon regions” in the geographical dimension.

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