Alma Mater Studiorum – Università di Bologna

DOTTORATO DI RICERCA IN

Architettura

Ciclo XXIX

Settore Concorsuale di afferenza: 08/C1 Design e Progettazione Tecnologica dell'architettura

Settore Scientifico disciplinare: ICAR/12 Tecnologia dell'Architettura

FROM SMART TO GREEN CITIES: A KPI-BASED MODEL FOR THE BUILT ENVIRONMENT REGENERATION.
A study of application in Bologna

Presentata da: **Saveria Olga Murielle Boulanger**

Coordinatore Dottorato

Giovanni Leoni

Relatore

Andrea Boeri

Co-relatori:
Danila Longo
Giovanni Fini

Esame finale anno 2017

This PhD thesis is Climate KIC labelled (European Institute of Technology).

A Daniele

Abstract

Smart City (SC) emerged during the end of last century as a reference concept for shaping the city of the future. The literature review shows how SC originates from a debate questioning about the future of cities in a world continuously object of pressures: resource scarcity, economic crisis, lack of social identity, besides continuous input from technologies. The progressive permeating of innovative devices, simplifying people life or enabling them in networking and knowledge, led to relevant modification of the built environment, in order to make cities able to use them. Scientists, from the end of the previous century, started to argue about digital cities, where everything would have been possible without moving from one place to another and where real physical space would have been left only for social interactions. From this utopia, the debate evolved, mainly because of the awareness about the weight of human fuel-based economy on Earth and of reflections about climate change. Today the relevance of SC is high and it seems that ICT technologies are definitively part of the built environment. On one side, in fact, the European Commission ask for more innovations and strategies involving technologies as key enablers, on the other side, the market of technologies is growing day by day. Nevertheless the topic is still onto development and evolution. The boundaries of this theme are in fact not clearly defined because the application of the approach into real contexts is still under validation and monitoring. Technologies, and mainly ICT, emerged as pervasive innovations, finding application on all levels of people life. But potentialities given by the study of new urban development, considering the potentialities given by new technologies, as well as by sustainable and more equitable strategies, are wide and interesting (Coutard et al., 2014). The word "smart" refers therefore not only to the ICT component of city but it also refers to the need of facing an increasing

complexity involving all sectors of cities. The extend of approaches, applications, testing and theories coming along with the SC topic oblige the research to critically and extensively study those elements, broadening the analysis to additional experiences, such as those referred to green and resilient. Nevertheless, the connection among innovative devices and built environment, as well as the more general architecture of cities, seems to be left in the background of this debate on SC.

The present work deals with the relationship between the new urban approach called SC and the definition of designing strategies for regenerating the existing built environment on a more sustainable, safer, resilient and smart perspective and broadening the analysis of approaches to Green and Resilient experiences. The research studies these approaches deepening the relation among architecture technology and urban planning, with a specific insight into a step-by-step project approach and a KPIs performance assessment. In addition the research is framed under the Climate KIC PhD label. The main basic perspective of this analysis is the necessity perceived by municipalities and designers of assessing holistic projects and strategies on urban systems, considering available technologies, sustainability and urban resilience as key elements for developing new strategies meeting current challenges.

The research is structured in two sections and five chapters. The first section investigates the literature about smart, green and resilient cities analysing theories, practises and assessment instruments, while the second section propose a new KPI and scenario-based model for addressing the regeneration of the existing built environment, at the district level.

Table of contents

Introduction

The smart city (SC) issue is a wide and varied theme still in a progressive development and evolution. The boundaries of this theme are still not clearly defined because the topic is recent and the application into real contexts is still under validation and monitoring (Nam & Pardo, 2011). Nevertheless the potentialities given by the study of new ways for urban development, considering the related innovative technologies as well as sustainable and more equitable strategies, are wide and interesting (Coutard et al., 2014). The extend of approaches, applications, testing and theories coming along with the SC topic oblige the research to critically and extensively study those elements, in order to gain a deep insight on the theme. Generally, the SC is intended as a urban strategy where a wide application of technologies (often Information and Communication technologies – ICT) is at the centre; where there is a specific attention to communities and their involvement and finally where there is an attention to sustainability and climate change. The potential results expected by hyper-connected devices in delivering an efficient and optimized configuration of urban systems and cities' services are wide and over-discussed into this current debate. Nevertheless, the connection among those devices and the built environment, as well as the more general architecture of cities, seems to be left in the background (Antonini et al., 2015).

The discourse about the interrelations between all these new components with the built environment and the analysis of the active role, that each element (building, devices, networks) can have into shaping the future city, needs to be addressed by future researches as well as the investigation of the effects of such strategies in a long-term perspective. Hence, the monitoring is important to be addressed, as well as the reflection on step-by-step phases for designing holistic intervention on the urban system. Some researches have already approached the investigation of monitoring, key performance indicators (KPIs) and SC indexes (Caragliu, Del Bo, & Nijkamp, 2011; Monfaredzadeh & Berardi, 2014). However, these studies show the complexity of the topic and the necessity for improving them, since analysis are conducted with specific and different perspective depending on the particular target and objective. Often in addition, the definition of such indexes is the result of a ranking perspective among projects (*ex post* approach), more than of a motivated planning (or support) aim (*ex ante* approach).

The present work deals with the relationship between the new urban approach called SC and the definition of designing strategies for more sustainable urban developments. The research studies the SC approach deepening the relation among architecture technology and urban planning, with a specific insight into a step-by-step project approach and a KPIs performance assessment. The main basic perspective of this analysis is the necessity perceived by municipalities and designers of assessing complete projects and strategies on urban systems, considering available technologies, sustainability and urban resilience as enablers of more holistic approaches (see II.3 Interviews on urban evolution , p. 362).

The attention that the topic records on the international level and the connection with some of the most challenging trends, with relevant impacts on urban systems, justifies the interest for the topic. In particular the following trends are considered as main elements to be evaluated:

- Increasing and fast concentration of interacting and interloping functions and activities triggering urban systems off important dynamics of economics development but also off high levels of complexity and high environmental impacts. This phenomenon is evident worldwide but with different results in dependence with the geographical area: e.g. in Asia and Africa, it triggers off intense urban drift processes (United Nations, 2014); while in America and Europe, it evidences the concentration and separation of functions (tertiary, commercial, residential) in specific areas of the territory and the extension of urban sprawl (Hajer & Dassen, 2014).
- The diffusion of ICT (Information and Communication Technologies) devices gives resources and potentially useful instruments for ruling and effectively managing high level of complexity as those concerning urban systems. These instruments allow the collection and processing of high amount of information, also on real time, which is important for directing more effectively

urban strategies and projects, even on an energetic, functional and comfort point of view.

- The diffusion of SC notion is still not completed by a clear definition of its potentialities, specificities and instruments. Intuitively, the topic appears to be related to a city able to integrate technological instruments and using them for knowledge improvement about the dynamic conditions for its functioning, control and optimisation. Moreover, in absence of a reference framework, the proliferation of definitions, opinions and approaches makes the clarification of the topic more difficult, and it makes the research on the topic spread.
- The uncertainty on SC framework and the proliferation of definitions didn't hinder the penetration of new technologies and devices into urban systems: their constant development and the market absorption make expectable a continuous and massive penetration with relevant impacts on built environment, energy/resource consumption and life quality. Understanding the extent of such transformations for integrating and exploit them into the regeneration of territories will involve completely architects and urban planners. The planning practise, that SC is contributing to create, have strictly interdisciplinary features: technological (ICT, electrics, etc.) ones as well as architectonical and urban one are unavoidable.

The purpose of the research is to provide operators in the sector of ToA (Technology of Architecture) with applications on urban built environment, and, in particular, to designers and municipalities managers, a decision making tool allowing the selection of best processes, phases, approaches and finally specific actions for addressing the urban built environment mitigation and adaptation to climate change.

Specific objectives of the research

On the basis of the general frame described, the main research objective is the identification of main constitutive and successful elements of a SC, aiming not only to address actions through the pervasive use of technology, but mainly to solve major challenges of urban systems and to answer to new built environment requirements, such as to respond to climate change issues, to make systems more resilient and to pursue social inclusion. The research questions underpinning the research are the following:

- Assuming the relevance acquired by SC inside urban policies all around the world, can Smart City Strategies really meet actual challenges that cities need to face?

- What are the main successful elements of a SC approach?
- What are the new requirements complex urban contexts need to meet?
- How is it possible to measure and evaluate performances of SC strategies into a long term perspective?
- Finally, how can a new smart approach be developed to accelerate the transition of cities toward more inclusive, sustainable, green and smart systems?

Link with Technology of Architecture and Climate KIC

The research is declined under the Technology of Architecture (ToA) field of interest. The relevant involvement of natural and built environment into the SC topic, the increased knowledge on buildings and public spaces performances resulting from the inclusion of technologies, new devices, the increased necessity to design holistic strategies for mitigating climate change, as well as the increased need for designing in collaboration with other relevant fields of interest, justifies the decision of studying the subject of SCs on the ToA perspective. In particular, the research is focused **on the control of the design process with an insight on KPIs associated to the topic**.

In addition, the research is framed under the Climate KIC PhD label, which is a European education program supported by the EIT – European Institute of Innovation and Technology. Therefore, Climate KIC assumes climate change as a reality and they support researches aiming at including mitigation and adaptation strategies into all levels of society. In order to respond to this preliminary objective, the research decided to address the analysis of urban evolutions and SC with a specific insight on climate change. In addition, since the Climate KIC label request the definition of research outputs able to meet the gap among academia and real life / market, the research proposes, as an original content, an instruments (named Green City Circle - GCC, see Chapter 4, p. 205) for addressing the design process inside cities. In fact, there is the possibility to pursue after the PhD with the definition of a higher TRL for this instrument, by participating to other Climate KIC programs, such as the Green Garage (a start-up accelerator) or the Pathfinder funding program.

Specific results of the research

On the basis of the described objective, the main research results are the following:

• The identification of SCs main features, instruments, drivers, peculiar traits and trends as well as success factors (see Section 1, p. 51).

• The definition of a model (conceived as an organized structure for reality interpretation), named Green City Circle (GCC), for supporting and addressing the built environment design process in urban districts. The model aims to assess the system state of the art (through the use of KPIs), to organize the reflection about several projects with the technique of alternative scenario analysis, to reflect on the assessment of results, to ponder about stakeholder involvement, financing and timing. The application scale is the district/neighbourhood level (see Glossary-District and Neighbourhood, p. 20). This model is conceived as a supporting tool for planners and decision makers (see Section 2, p. 203).

Preliminary definitions

The complex and interdisciplinary nature of the topic justify the research decision to do not assume any of the existing definitions of SC, but to provide a deep analysis of the subject inside Section 1 (see Chapter 1, p. 53).

Nevertheless some other words need a preliminary definition.

At first the notion of design which is not only intended as a technical definition of a work of architecture, but also as a fundamental act of governance inside an integrated urban process characterised by a variety of relevant actors.

Then the notion of model, which is intended, into this work, as an organised structure for reality interpretation composed by several elements such as strategies, scenarios, actions and KPIs. Those elements contribute to the formation of an interpretation of reality targeted to address the design process. The research proposes the definition, as main output, of such a model composed not only by designing guidelines, but even more by a deep analysis of the state of the art, a definition of long-term visions and a preliminary evaluation of visions through the use of KPIs. The inclusion and study of KPIs inside this work is aimed at taking under control both qualitative and quantitative perspectives. The action inside the city is today the result of interloping interests and needs, so the proposed model aims to ponder before acting not only on different possible strategies, but also on the quality of these strategies (ISO/IEC JTC 1, 2014).

Often, the research cites the words "multi-level structure" and "integrated complexity". With these expressions it is intended to put the attention on the complex nature of the SC in itself. In particular, the SC is recognised to have a multiple nature applicable on different layers of the city and of governance process: it is assessed, in fact, that the topic has a strong multi-disciplinary evidence (Anthopoulos & Vakali, 2012; Caragliu et al., 2011). The notion of multi-level structure puts in evidence this stratified nature, as the SC can be described highlighting several possibilities of classification and thematic organisation. This multiplicity of levels can be read in different ways, depending on the approach. In particular, it is possible to evidence some of the most common layers where the SC is structured: 1) a process approach, where the definition of phases - or actions - is prior; 2) a sectorial approach, where the attention is focused on different urban layers (environment, economy, people, energy, mobility, governance); 3) an evaluation approach, where different indicators are structured; 4) an actor approach, where the variability of stakeholders are identified and analysed. All these approaches compose the notion of multi-level structure. This complexity is defined, into this research, as integrated because of the coexistence, inside the notion of SC, of all these approaches, but also as all these elements need to be integrated into a holistic understanding of the phenomenon, which could not be partial.

The last important preliminary definition, which constitutes also one of the limitation of the research is the notion of "district / neighbourhood". The word district refers to an urban area with different specificities. The debate about the identification of its key component is wide and extended in time (Balducci & Fedeli, 2007). Often it is identified as an administrative area as well as an area recognized by its inhabitants for variable reasons. Inside this research the district is considered as a structured portion of the city recognized by its citizens as an entity and where it is possible to analyse different and simultaneous phenomena on a simplified scale. The word neighbouthood is also often linked with the social dimension of urban space and with the identity of citizens in one or more physical spaces (Barton, 2000).

Glossary

Into this paragraph, the research aims to propose some definitions framing the development of the research. In particular are here highlited those definitions which are, inside the current debate about SCs and climate change, very used but still a few ambiguous. Definitions are presented in alphabetical order.

Anthropocene era

Anthropocene era is the geological definition of the current on-going era. Several studies, starting from those conducted by the Nobel Prize Crutzen show how the contemporary way of living is having geological impacts on the Earth environment mainly through land use changes, deforestation and fossil fuel burning . This epoch is defined as started about two century ago, in 1784, coinciding with James Watt's design of the steam engine.

- Crutzen, Paul J., The "Anthropocene", in Earth System Science in the Anthropocene, 2006, pp. 13-18, Springer Berlin Heidelberg, ISBN 978-3-540-26588-7
- Crutzen, P aul J., Steffen, Will, How Long Have We Been in the Anthropocene Era?, in Climatic Change, December 2003, vol. 61, issue 3, pp. 251-257
- Steffen, Will, et al. The Anthropocene era: How humans are changing the Earth system, in Global Change and the Earth System: A Planet Under Pressure, 2005, pp. 81-141

Climate Change

The IPCC defines climate change as "a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use". The Framework Convention on Climate Change (UNFCCC), in Article 1, defines climate change as: "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods". The UNFCCC makes a distinction between "climate change" attributable to human activities and "climate variability" attributable to natural causes.

- IPCC, 2013: Annex III: Glossary, in Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1447–1466, doi:10.1017/CBO9781107415324.031
- United Nations, United Nations Framework Convention on Climate Change, 1992, available at: https://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf

Coscienza di luogo (= Awareness of place)

With Coscienza di luogo it is intended a territorial characteristics in relation to which the territory is framed by a multiple presence or traditions, people behaviours, creativity and productive capacity. When a territory has a strong "coscienza di luogo" there is synergic reciprocity between productive system and natural environment and between productive system and cultural environment.

• Becattini Giacomo, La coscienza dei luoghi. Il territorio come soggetto corale, Donzelli editore, Roma, 2015

• Becattini Giacomo, Magnaghi Alberto, Coscienza di classe e coscienza di luogo. Dialogo tra un economista e un urbanista, in La coscienza dei luoghi. Il territorio come soggetto corale, Donzelli editore, Roma, 2015, pp.117-222

Digital city

A Digital city is a city giving high importance to web-based and ICT technologies for meeting social challenges on cities. Several definitions are present into the literature and some scientists affirm that Digital City is one of the major precursor of Smart City. Sometimes the term affers also to the virtualization of part of cities or services.

• Anthopoulos Leonidas, Fitsilis Panos, From Digital to Ubiquitous Cities: Defining a Common Architecture for Urban Development, in Intelligent Environments (IE), 2010 Sixth International Conference, pp. 301-306

• Couclelis Helen, The construction of the digital city, in Environment and Planning B: Planning and Design, vol. 31, issue 1, pp. 5–19, 2004

• Toru Ishida, Katherine Isbister (eds.), Digital Cities: Technologies, Experiences, and Future Perspectives. Lecture Notes in Computer Science, Springer Science & Business Media, 2000

District and Neighbourhood

The debate on district and neighbourhood definition is wide. In the last years, districts are seen as pilot dimensions for testing a wide range of innovative solutions and strategies, starting from French éco-quartiers to Smart Districts defined under the Horizon 2020 European Framework Program. However, many features can define the district as an urban entity: geography, sociality, administration, functions, etc. As a definitive version of the topic is not actually assumed into the international debate, this research decided to focus on district as an intermediate urban dimension between city and buildings being recognisable by its citizens; having a minimum physical dimension for implementing projects; having a recognised relevance in respect of the whole city; and being mixed-use or settled into a specific function (e.g. residential, commercial, etc.).

• Balducci Alessandro, Fedeli Valeria, Tracce di quartieri, in Territori della città in trasformazione. Tattiche e percorsi di ricerca, Franco Angeli editore, Milano, 2007

• Barton Huge, Sustainable Communities. The Potential for Eco-Neighbourhoods, Earthscan Publications Ltd, London, 2000

Greenhouse gas (GHG)

The IPCC describes GHG as "those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the Earth's atmosphere".

• IPCC, 2013: Annex III: Glossary, in Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1447–1466, doi:10.1017/CBO9781107415324.031

Information and Communication Technologies (ICT)

ICT technologies refers to a wide group of devices, application or instruments used for communication: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning. Inside the Smart City topic, it is usually related to all instruments enabling people acquire knowledge on city's components; or enabling object to have automatic responses as well as enabling people acting directly on urban parts, etc.

• Kramers Anna, et al., Smart sustainable cities – Exploring ICT solutions for reduced energy use in cities, in Environmental Modelling & Software, vol. 56, June 2014, pp.52-62

Intelligent City

The word intelligent refers to cities and territories "with high capability for learning and innovation, which is built-in the creativity of their population, their institutions of knowledge creation, and their digital infrastructure for communication and knowledge management" (Komninos 2006). Inside the debate about Smart Cities, Intelligent cities are often included as part of the complex system of strategies inside the smartness of a city.

• Komninos, Nico, The architecture of intelligent cities: integrating human, collective and artificial intelligence to enhance knowledge and innovation, in IEEE 2nd IET International Conference on Intelligent Environments, 2006, pp. 13–20

• Nam Taewoo, Pardo Theresa A., Conceptualizing smart city with dimensions of technology, people, and institutions, in Proceedings of the 12th Annual International Digital Government Research Conference: Digital Government Innovation in Challenging Times, 2011, pp. 282-291

Mitigation and Adaptation to Climate Change

The IPCC describes mitigation as "a human intervention to reduce the sources or enhance the sinks of greenhouse gases" including also action targeted to the control and reduction of other substances (e.g. particulate matter, etc.) ; while it defines adaptation as "*the process of adjustment to actual or expected climat and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects*". In general, both mitigation and adaptation are referred to human actions for reducing the effect of anthropogenic activities on Earth (mitigation) or to adapt to climatic changes (adaptation).

- Edenhofer, O., R. et al. (eds.), Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2014
- Smit Barry et al., An anatomy of adaptation to climate change and variability, in Climatic Change, 2000, vol. 45, pp. 223-251

Resilience

Resilience can be described as the ability of a system to react to stresses and schocks. The word comes from the latin *resilire*, meaning "to spring back", in fact the word "resilience" was first used by physical scientists to denote the characteristics of a spring and describe the stability of materials and their resistance to external shocks. It is usually associated to several disciplines and it declines its meanings according to them. Some variant are "ecological resilience", "social resilience" and "disaster resilience". This work considers "resilience" applied to cities as climate resilience. Consequently, it assumes the significance of urban capacity to quickly react to unexpected events (floods, hurricane, etc.) or to being able to adapt or still react to softer events (heat islands, energy peaks demand, etc.).

- Brown Eleanor D., Byron Williams K., Resilience and Resource Management, in Environmental Management, 2015, issue 56, pp. 1416–1427
- Davoudi Simin, Resilience: A Bridging Concept or a Dead End?, in Planning Theory & Practice, 2012, vol. 13, n°. 2, pp. 299–307
- Shaw Keith, "Reframing" Resilience: Challenges for Planning Theory and Practice, in Planning Theory & Practice, 2012, vol. 13, n°. 2, pp. 308-312
-

Urban metabolism

The expression "urban metabolism" means the capacity of cities to produce and generate energy, materials and growth needed for its subsistence. The urban metabolism is defined by Kennedy (2007) as "the sum total of the technical and socio-economic processes that occur in cities, resulting in growth, production of energy, and elimination of waste". The international debate refers also to the city as an ecosystem (or a body), in which the organism need to be in balance. As a consequence, the city need to balance production and natural resources available.

- Paulo Ferrão, John E. Fernández, Sustainable urban metabolism, MIT press, 2013
- Kennedy Christopher, Cuddihy John, Engel-Yan Joshua, The Changing Metabolism of Cities, in Journal of Industrial Ecology, 2007, vol. 11, issue 2, pp. 43-59

Urban sprawl and land use

The two term urban sprawl and land use are often cited togheter as they concur to a common definition of the usage of space around cities, typical of the XX century. Urban sprawl, in fact, is defined by the Chester County Planning Commission (1999), as "a spreading, low-density, automobile-dependent, development pattern of housing, shopping centers and business parks that wastes lands needlessly". In general, it identifies the extensive use of land outside cities, commonly the countryside, on a car-based planning methodology, low-dense and with an high subdivision of functions (big shopping centers, big industrial areas, etc.).

- Gillham Oliver, The Limitless City: A Primer on the Urban Sprawl Debate, Island Press, 2002
- Johnson P. Michael, Environmental impacts of urban sprawl: a survey of the literature and proposed research agenda, in Environment and Planning A, 2001, vol. 33, pp. 717-735
- Burdett R., Endless City, London, Phaidon Press, 2010
- Cabana R., Wagner F.W., The International faces of Urban Sprawl: lessons learned from North America, Waterloo (Ontario), Department of Geography, University of Waterloo, 2006

Boundaries of the research

The research is stricktly related to the field of Technology for Architecture but with a multidisciplinary perspective in order to gain a deep insight on the SC topic. However some boundaries are defined. The research decided to operate its analysis, of SC processes and assessment, inside the ToA field of interest but including correlations with urbanism, analysis of best practices, KPIs and urban evolution. In particular, real case studies of brownfields (selected on different bases inside Europe), indexes assessment systems and KPIs are referred to the analysis of the built environment performance into the interferences with open space in-between buildings. Even if other aspects, for example linked with economy, public-private partnership (PPP), electricity, social sciences, are of great interest for the topic, the research decided to do not examine them in deep.

The second important limitation of the research field is the application of the model inside the boundaries given by the definition of district and neighbourhood. As the aim is to study a model for assessing the design of multi-layer projects inside the city system, the number of variable to consider is large due to: the complexity of the city in itself, the presence of simultaneous top-down and bottom-up approaches and the general presence of combined and multiple issues. For this reason the field of application and study of this model is selected to be the district/neighbourhood dimension, as a simplified scale of analysis. Besides, the dimension of the district seems to represent an acceptable intermediate portion of the whole city where local and global phenomena can be observed in their interferences.

Methodology of the research

The analysis underlying the research is mainly bibliographic, whit the large use of databases, such as Google Scholar, which can be reasonably considered the largest and most accessible scientific database; Cordis, the EU web portal where funded projects are recorded; scientific periodicals and books. The state of the art review (chapter 1, 2 and 3) was set to screen researches about SC topic including definitions, approaches and case studies, by using a systematic literature analysis. Two specific systematic reviews were performed: the first one on Google Scholar, the second one on Cordis. Both adopted a methodology coherent to Cooper taxonomy (Cooper, 1988). Google Scholar was searched including all kind of documents (reports, scientific papers, theoretic analysis, methodologies, assessment and indexes, research outcomes) in a time range between 2000 and 2016. Complementary papers and systematic analysis were used for covering the range of 90s (Cocchia, 2014). The Cordis database was quested for projects under the Horizon 2020 work programme, under the topic Smart Cities and Communities and gave the base for the case study analysis. For each analysis the main refiner was the connection with sustainability and climate change. The sources analysed and the outcomes were organised in worksheets, which can be found at the end of chapter 2 and 3.

The research process was composed by several phases: 1) background definition; 2) overview of sources, definition of boundaries and expected outputs; 3) refinement of source analysis on the base of the expected outputs; 4) definition of the originality of the research and positioning inside the current debate; 5) design of the model GCC, which constitute the main output of this research; 6) simulation of the model inside the real context of Bolognina; 7) evaluation of results and final discussion.

Research support worksheets

The research defined a few number of supporting tools for cataloguing case studies, bibliography and KPI instruments.

Structure of bibliography worksheets (Figure 0.1)

Bibliography cataloguing process and worksheet definition followed the following steps:

- description of main bibliography information
- description of author and definition of him other interesting works to read
- description of contents highlighting innovation aspects and link with other sources
- list of related sources

Structure of case studies worksheets (Figure 0.2)

The methodological research iter used for cataloguing case studies followed the following steps:

- description of the city highlighting main information
- description of context of application, if different from the entire city
- description of main SC general process/es used
- description of main actions implemented or under implementation
- analysis of innovative aspects

Structure of KPI instruments worksheets (Figure 0.3)

The methodological research iter used for cataloguing case studies followed the following steps:

- description of model application and typology of model
- description of KPI structure

Figure 0.1 Bibliography worksheets

Schedatura materiale di ricerca _ PhD student Saveria O. M. Boulanger
Dottorato di ricerca in Architettura

Scheda n°

Dati di analisi documento

Dicitura bibliografica:

Titolo:

Autore:

Contenuto in:

Anno:

Editore:

Luogo:

N° pagine o fogli:

Tipologia del documento:

Parole chiave di riferimento:

Dati di analisi autore

Temi di ricerca dell'autore:

Eventuali pubblicazioni correlate da consultare:

Dati di analisi contenutistica

Temi trattati:

Concetti fondamentali di interesse:

Innovazioni e avanzamenti rispetto alla letteratura precedente:

Schedatura materiale di ricerca _ PhD student Saveria O. M. Boulanger
Dottorato di ricerca in Architettura

Dati relazionali

Eventuali relazioni con altri documenti visionati:

Riferimenti bibliografici da consultare:

- analysis of innovative aspects and KPIs

Thesis outline

Chapters 1-2-3. The State of the Art.

The first three chapters of the research are targeted at defining the current state of the debate about urban evolution and, in particular, about SC. In particular, the first chapter outlines the analysis of SC definitions both inside scientific papers, European documents and theoretical studies. Chapter 2 outlines the analysis of European case studies with the aim of identifying key elements and success factors. Finally, the third chapter analyses KPIs inside a number of *ex post* and *ex ante* instruments (e.g. rankings, rating sustems, EU projects, etc.).

The Conclusion of Section 1 defines some key elements and trends about SC and come to the reflexion about extending the definition to a "green city" approach, considered as an exented evaluation of smart, green, resilient and integrated approach on cities.

Chapter 4. Green City Circle.

The development of a tool for addressing and assessing the design of built environment inside urban districts is shown. Starting from the necessity, perceived by municipalities and several scientists (see II.3 Interviews on urban evolution, p. 362), of instruments able to focus on portion of cities as systems, and not as the sum of single parts, and to guide the definition of a holistic project, the Green City Circle model have been purposely designed through the definition of a step-by-step approach and a scenario proposition. The relation between the built environment and the space in-between buildings is investigated through the identification of KPIs as assessment indicators for existing urban built environment performance analysis.

Chapter 5. Application of the model on the Bolognina district.

The set GCC was tested on Bolognina district in order to simulate the use of the model on a real context. The effectiveness in defining a deep comprehension on the state of the art of the district, through the application of KPIs, was analysed as well as the potentialities given by the proposition of different scenarios.

Chapter 6. Discussion

The GCC was finally evaluated with the analysis of its replicability and scaling-up potential, on other districts of the same city. Besides, the discussion involved also the relation of the model with the current urban framework (mainly at policies level). This chapter also outlines the potential of the research for further studies.

Table 0.3 deepens the Research Work Plan as defined through the development of the research.

Table 0 . 1 Research steps and actions

Steps	Actions
1. Scientific problem definition	Bibliographical investigation Construction of network (professionals, economists, PA energy managers, tutor and co-tutor, Climate KIC)
2. Research Program definition	Main bibliography definition (scientific papers, cities reports, EU documents) Analysis of EU funded projects inside the SC topic Analysis of existing similar researches and master and PhD thesis Drafting logical index
3. Research	Interviews and interaction with the network Research on primary sources Personal visiting of interesting European cities (Munich, Copenhagen) Comparative evaluation on KPI models and case studies Identification of main challenges (urban, technological, etc.) Preliminary definition of a model for addressing the process of urban built environment adaptation to climate change
4. Discussion and evaluation	Results evaluation Simulation of model application inside the real neighborhood of Bolognina (IT, city of Bologna) Observatory Participation inside Bolognina
Definition of a support model for addressing the design of urban built environment on the mitigation and adaptation to climate change perspective.	

Table 0 . 2 Thesis outline

Part of the work	Ch.	Methodology	Sources typ.	Ref. sources
Background definition and literature analysis	1	- Systematic literature analysis	-Scientific paper -Theoretical studies -Policies on EU or national level - Books	-Google Scholar -Scientific periodical
Analysis of KPIs and performance assessment	3	- Systematic literature analysis	- Indexes - Ranking systems - Rating systems - EU projects	- Google Scholar - Specific portals - Cordis
Analysis of case studies	2	- Systematic literature analysis	- EU projects	- Cordis
GCC model outline	4	- Systematic literature analysis - Case study analysis - Interviews	-Scientific paper -EU projects - Interviews with professionals and researchers on the topic	-Google Scholar -Cordis -Meetings
Simulation of the model inside Bolognina	5	- Observatory Participation - Analysis of Bologna policies - Analysis of current existing projects	- Interviews - Bologna Policies - Citizens interviews	- Personal meetings - Personal participation on Bolognina district life - Bologna municipalities managers and policies databases

Figure 0 .2 Case study analysis worksheets

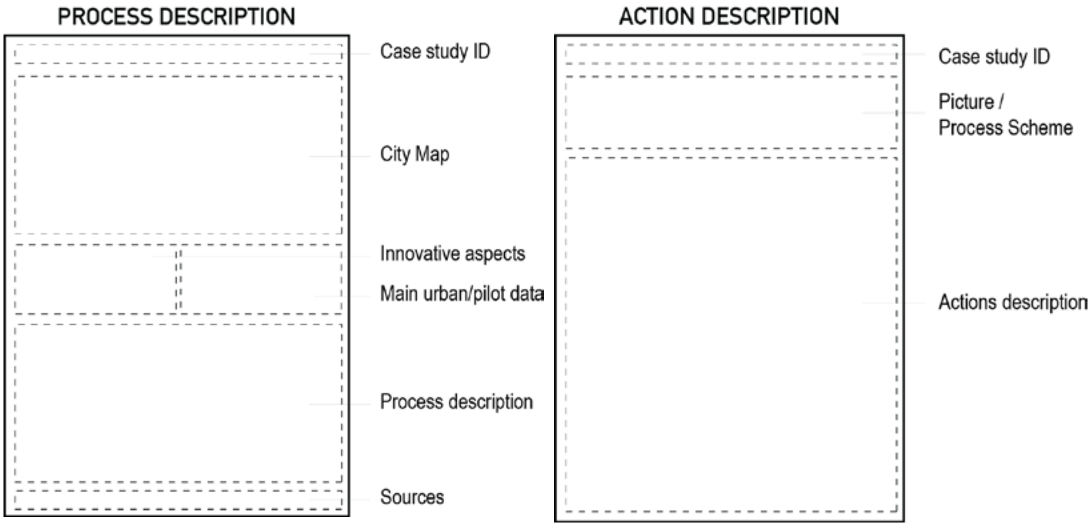


Figure 0 .3 KPI model worksheet page 1

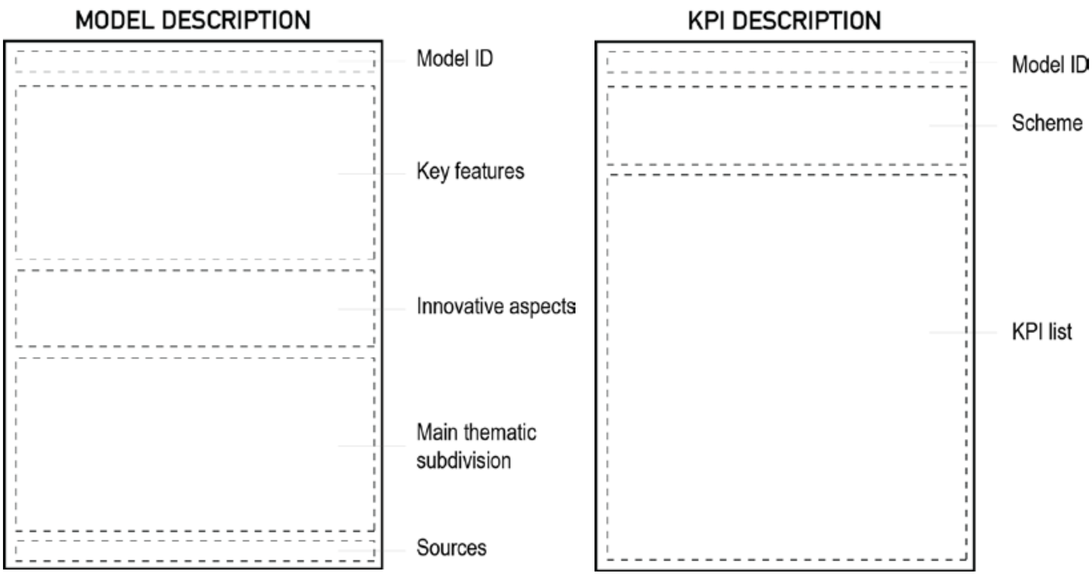


Table 0 . 3 Work Program

Step	Objectives	Actions	Speakers	Step results
1. Subject Definition	Identification of the scientific challenge to be addressed and hypothesis on scientific contribution	Preliminary bibliographic investigation and identification of a preliminary state of the art	Department professors	- Work Program (WP) draft
2. Subject checking	Identification of feedbacks outside the research area – multidisciplinary approach	Intersections with similar subjects inside other disciplines. Check with tutor and experts	Tutor External experts	- General WP identification
3. WP definition	Objectives, methodologies, research boundaries ad expected results identification	Annotated bibliography inside and outside the disciplinary sector. Definition of expected results.	Tutor Researchers External experts	- Table of content draft - WP
4. WP checking	Definition of the WP and subject selection validity	Analysis of similar researches (both on thematic and methodological aspects). Check with tutor	Tutor Researchers Climate KIC External experts	- WP - Operative plan and Gantt diagram draft - Annotated table of contents
5. Preliminary bibliography construction	Creation of a base knowledge on the subject and definition of major addressing resources	Bibliography research and identification of main and secondary sources. Annotated archive of bibliography. Worksheets.	Tutor	- Bibliography archive with worksheets completion. - Annotated bibliography
6. Network construction	Creation of an evaluation background for the research	- Conferences on the subject - Internship inside the MoB - Climate KIC activities inside Europe - ToA-Unibo research group - Cultura Democratica Foundation	Climate KIC Tutor and UNIBO researchers MoB managers Nomisma Cultura Democratica	Evaluation background and stable network of stakeholder definition
7. European case studies analysis	Definition of an archive of European case studies in order to evidence trends, key points and success factors	Worksheet for case studies cataloguing. Analysis of related bibliography and worksheet completion.	Climate KIC network Municipality of Bologna network Nomisma network	- Control list for methodological evaluation and selection of case studies in EU - Worksheet completion - Case studies archive
8. Italian case studies analysis	Definition of an archive of Italian case studies in order to evidence trends, key points and success factors	Worksheet for case studies cataloguing. Analysis of related bibliography and worksheet completion.	Climate KIC network Municipality of Bologna network Nomisma network ANCI	- Control list for methodological evaluation and selection of case studies in Italy - Worksheet completion - Case studies archive
9. Ex ante and ex post instruments analysis	Definition of an archive of ex ante and ex posts instruments in order to evidence KPIs	Worksheet for instruments cataloguing. Analysis of related bibliography and worksheet completion.	EU projects networks ANCI UNIBO	- Control list for methodological evaluation and selection of instruments - Worksheet completion - Instruments archive

10. Compared evaluation of case studies and KPIs	Analysis of trends, differences and common points	Definition of most used KPI. Definition of processes and trends. Definition of innovative approaches. Check with tutor	Tutor	Trend scheme
11. GCC preliminary definition	Production of a preliminary structure for the GCC model, with main phases, key elements, main outputs	Definition of the proposed model, its boundaries and its background knowledge (KPI, scenario)	Tutor External experts	Model draft
12. GCC simulation inside Bolognina neighbourhood	Simulation of the model inside a real context	Definition of a simulation for validating and setting the identification of the GCC model	Citizens Municipality of Bologna District managers Tutor	Implementation plan for the Bolognina neighbourhood
13. GCC identification and checking	Feedback based on the simulation inside the Bolognina context	Final development of the model	Tutor	Final model scheme and definition of complementary worksheets
14. Conclusions and discussions	Definition of a GCC model evaluation in term of applicability, replicability, scaling-up and in relation with current policies	Definitive redaction of the research, setting of results and proposition of further developments	Tutor	- Research redaction - Further works proposition

Chapters abstract (ENG/ITA)

CHAPTER 1:

Understanding Smart Cities. From theoretical approach to driver analysis

Comprendere la Smart City: approccio teoretico e analisi degli elementi motori

Abstract / *Sommario*:

The Smart City topic emerged in last years as a reference concept into the evolution of contemporary urban analysis. Inside this debate, mainly centred on networks and digital issues, the urban architecture seems to be left in the background. An analysis able to highlight the complex relations among built environment, open spaces, networks, ICT and stakeholders is necessary in light of potentialities given by new technological systems and by the new sustainability and resilience objectives of urban contexts. These objectives ask cities to answer to emerging problems and challenges needing new and updated urban analysis instruments. In addition, the big diffusion of innovative technologies links together all single elements composing the urban system into a strict relation. This relation is not made by the simple juxtaposition of elements but by a more complex system of interrelations and links that need to be analysed. Chapter 1 aims to analyse these relations putting in evidence the multiplicity of theoretical approaches and analysing the main drivers and instruments composing the reflexion about urban projects.

Il tema della Smart City è emerso negli ultimi anni come concetto di riferimento nell'analisi dell'evoluzione urbana contemporanea. All'interno di questo dibattitto, prevalentemente incentrato sui temi delle reti e del digitale, il tema della progettazione dell'integrazioen tecnologica per la rigenerazione di ambiti urbani in

chiave sostenibile è prioritario. Un'analisi che metta in luce le complesse relazioni tra costruito, spazi aperti, reti, ICT, attori è necessaria alla luce delle potenzialità offerte dai nuovi sistemi tecnologici e dagli obiettivi di sostenibilità e resilienza che la città contemporanea si pone. Tali obiettivi richiedono alla città di rispondere a nuove problematiche ed esigenze, che necessitano di strumenti di analisi della realtà aggiornati. La grande diffusione di nuove tecnologie lega, inoltre, i singoli elementi della città in una stretta interrelazione, rendendo il contesto urbano un sistema sempre più complesso, formato non solo da singoli componenti giustapposti, ma da sotto-sistemi che si relazionano tra loro secondo variabili diverse e non lineari. Il capitolo si occupa di indagare queste relazioni, mettendo in evidenza la molteplicità di approcci teorici al tema ed analizzando i principali motori di sviluppo e gli strumenti che influenzano la riflessione sul rapporto tra ambiente costruito e integrazione tecnologica.

Main results / *Risultati principali*:

The study about SC shows how cities can be analysed through a factorization in different layers. Those layers can be analysed singularly (and often are) but in reality they act with a strict correlation composing a very complex and multi-variable system. Inside each single layers it is possible to act, for example, through the use of different ICT technologies with the aim to improve the general performance. Results and objectives that these improvements aim to achieve can be many. In the case of SCs they seem to be strictly related with: 1) climate change; 2) reduction of urban sprawl and land use; 3) presence of innovative technologies into people life. In addition, the research noted how the typologies of urban actions, named smart, need an integrated involvement of several and different stakeholders: PA, small and big companies, association networks, energy providers, citizens which are not more considered only as end-users but also as prosumers (wealth and growth producers). The objective of that new way of considering citizens and of this complex group of stakeholders seems to be the creation of an urban environment with high cultural, social, creative, participative perspective, named by some authors "coscienza di luogo" (=place awareness) (G. Becattini, A. Magnaghi, 2015) having similarities with Italian industrial districts. Hence, the SC appears to be a complex entity and a way of planning targeted to the resolution of some of the more pressing and current challenges (such as sustainability, resilience, land use, etc.) with the involvement of a wide panel of stakeholders and processes.

Lo studio sulle città smart tende a mostrare come le città possano essere *analizzate scomponendole in più elementi o layer giustapposti. Tali layer possono essere analizzati singolarmente ma, nella realtà, sono profondamente interrelati tra loro, tanto da costituire un sistema complesso di variabili di tipo non lineare. All'interno dei singoli layer, e tra di essi, è possibile intervenire, ad esempio con le nuove tecnologie ICT, al fine di migliorare il comportamento complessivo del sistema. I risultati e gli obiettivi che tali miglioramenti si pongono possono essere molteplici. Nel caso della città smart questi appaiono essere fortemente legati a: 1) cambiamenti climatici, esplicitandosi in una ricerca di strategie di mitigazione e adattamento, nonché di resilienza delle città ; 2) riduzione del consumo di suolo e dello sprawl urbano, acuito dalle variazioni geo-politiche e climatiche che causano forti ondate di immigrazione verso l'Europa; 3) progressivo inserimento delle nuove tecnologie digitali nella vita quotidiana delle persone, che si presenta come un dato oggettivo e che comporta una serie di evoluzioni nell'utilizzo dello spazio fisico, urbano o domestico.*

Inoltre, si rileva come uno dei principali fattori di successo nei progetti smart sia un coinvolgimento integrato di attori diversi al fine di migliorare l'efficienza e la sostenibilità nel lungo termine: pubbliche amministrazioni, imprese grandi e piccole, reti di associazioni, gestori energetici, fino ai cittadini, considerati non più solo come utilizzatori finali (end-users) ma come attori attivi del progetto e "produttori" di crescita (prosumers). Obiettivo sembra essere la costituzione di un ambiente urbano -culturale, creativo, partecipativo- favorevole alla crescita, definito da alcuni autori "coscienza di luogo" (G. Becattini, A. Magnaghi, 2015), non così lontano da quel substrato culturale-produttivo tipico dei tradizionali distretti industriali italiani. La città smart appare dunque come un'entità complessa, mirata alla risoluzione di alcune tematiche attuali rilevanti (come la sostenibilità ambientale, la resilienza, il cambiamento climatico, l'uso di suolo) e composta da una pluralità di azioni e di attori che tendono ad evidenziare come il tema della smartness sia limitante nello studio approfondito dei sistemi urbani. La tesi, infatti, nei capitolo 2 e 3 estenderà la definizione di Smart and un concetto di Green, dove integrazione, intelligenza e sostenibilità sono inclusi.

Main source / *Principale fonte bibliografica di riferimento*:

Together with the bibliographic sources cited at the end of the work, which includes regulations, EU and national reports, books and monographs on the topic, conference proceedings and scientific publications, one of the most used source about SC was the book edited by Oriol Nel-lo and Renata Mele. This publication collects several scientific contribution and gives a through look on cities with a specific attention to sustainability, innovation, technologies, climate change, immigration and land use. On the other side, for a quick approach on the SC theme, the books of Giuliano dall'O and Bonomi – Masiero are considered as a reference. A last reference source was identified into the book of Walter Vitali, for its reflection on cities.

Insieme alle fonti bibliografiche citate alla fine del presente lavoro, che includono fonti normative, report europei e nazionali, volumi di approfondimento sui diversi temi trattati, atti di convegno di settore e articoli pubblicati nelle principali riviste, uno dei volumi di consultazione che si possono considerare di riferimento per approfondire il tema della smart city è il volume edito da Oriol Nel-lo e Renata Mele. Tale pubblicazione raccoglie prestigiosi contributi e fornisce uno sguardo approfondito sulle città, con una particolare attenzione ai temi della sostenibilità, dell'innovazione, delle tecnologie, dei cambiamenti climatici, dell'immigrazione, del consumo di suolo. Invece, per un approccio più rapido al tema si considerano fonti di riferimento il libro di Giuliano dall'O e il libro di Aldo Bonomi e Masiero. Un'ultima fonte di riferimento nell'approccio critico al tema della città è stato fornito in particolar modo dal libro di Walter Vitali.

Oriol Nel-lo and Renata Mele (eds), Cities in the 21st century, Routledge, 2016, New York
Giuliano Dall'O, Smart City. La rivoluzione intelligente delle città, Edizioni il Mulino, 2014
Aldo Bonomi, Roberto Masiero, Dalla Smart City alla Smart Land, Marsilio Editore, 2014
Walter Vitali, Un'agenda per le città. Nuove visioni per lo sviluppo urbano, il Mulino, 2014

Keywords: smart city, participation, stakeholder, climate change, urban sprawl, theoretical approach, interrelated layer, innovation, ICT, coscienza di luogo

CHAPTER 2:

Approaches from Smart to Green Cities. A case studies interpretation

Approcci dalla città Smart alla città Green. Interpretazione di casi studio

Abstract / *Sommario*:

The theoretical analysis conducted into chapter 1, which led to the identification of the SC as a complex entity and aiming to answer to some of the most pressing urban challenges, pushes the research in investigating how SC is really applied into physical contexts. As a consequence, chapter 2 investigates the application of those strategies in a selection of case studies, by identifying some of the major trends. The analysis of case studies was made considering both the dimension of strategies application (a street, a district, the entire city) and of typology of cities (big, medium, small or entire regions/countries). The selection of case studies was made considering the following basis:

- analysis of cities with different dimensions;

- analysis of different typologies of approaches;

- analysis of winning cities of European funding opportunities (Horizon 2020, FP7, Smart Cities and Communities);

- availability of data on online platform, scientific publications, Cordis platform;

- analysis of strategies declaring the name of being smart.

Selected cities have been catalogued through the use of worksheets giving a synthesis of actions and approaches.

L'analisi teorica, condotta nel capitolo 1, che ha portato ad identificare la città smart come realtà complessa avente l'obiettivo di rispondere ad alcune delle problematiche più urgenti della società contemporanea, spinge la ricerca ad investigare l'approccio SC nei contesti urbani reali. Il capitolo 2 indaga l'applicazione di queste strategie attraverso una selezione critica di casi studio identificando alcuni trend fondamentali, analizzati da un lato dal punto di vista dell'oggetto di applicazione delle strategie (una strada, un quartiere o l'intera città), dall'altro dal punto di vista delle tipologie di città (metropoli o megalopoli, città medie o intere regioni). La scelta dei casi di studio si basa sulle seguenti premesse:

- individuazione di città di diverse dimensioni che hanno sperimentato approcci di tipo smart;

- individuazione di diversi approcci progettuali/di azioni messe in campo;

- selezione di città risultate vincitrici di progetti Europei sulla città smart (Horizon 2020 e FP7, bandi Smart Cities and Communities);

- disponibilità di materiale di studio online, sui siti delle amministrazioni, oppure sul sito Cordis, dell'Unione Europea.

Le città analizzate sono state catalogate attraverso l'utilizzo di schedature che propongono una sintesi delle strategie applicate e degli elementi di innovazione.

Main results / *Risultati principali*:

The analysis of real case studies gave to the research some instruments for understanding more deeply the needs of contemporary cities and how urban and technological projects can answer to them. The chapter puts in evidence how the real application of smart strategies fall within a broader definition of city where sustainability, resilience and technology contribute in building an integrated urban system able to answer to several challenges. In fact, the analysis of cases highlighted some important elements:

- the implementation of smart strategies includes in the majority of cases the application of ICT devices or other innovative systems (sensors, optical fibre, big data, data mining, etc.). This shows how the term SC is definitively anchored to the presence of ICT technologies. In few cases KETs (Key Enabling Technologies) are also implemented, such as biotechnologies, photonics, advanced materials, microelectronics, nanoelectronics, nanotechnologies and advanced constructive systems. The application of those typologies of innovations, even if enters into the category of technological implementation, seems to be less used in respect with ICT and users digital technologies.

- The presence of an urban transformation strategy based on a clear starting vision with an high national or local commitment (at political and administrative level) and the definition of long term development programs are generally success factors.

- The coexistence of a strategy for real stakeholders and citizens' involvement is also a success factor.

- Several projects also includes actions targeted to the creation of a creative and cultural environment, seeing in the presence of cultural heritage or in the presence of a cultural background a way of achieving urban objectives.

Some key factors are in line with some experience of the 1950's architecture and mainly with some reflexions of several architects (see for example reflections about participation by G. De Carlo, reflections about cultural heritage and urban city centres by S. Salvatori and L. Quaroni about urban context and environment, about urban space perception by K. Lynch, etc.).

Il confronto con sistemi urbani complessi reali ha fornito gli strumenti per comprendere più profondamente le necessità delle città contemporanee e come i progetti urbani e tecnologici possano rispondere ad esse. Il capitolo mette in luce come la reale applicazione delle strategie definite smart rientri all'interno di una definizione più ampia di città in cui sostenibilità, resilienza e tecnologia concorrono alla costruzione di un sistema urbano integrato rispondente ad una pluralità di necessità.

Infatti, l'analisi dei casi ha messo in luce alcuni elementi fondamentali:

- L'implementazione delle strategie definite smart include nella maggioranza dei casi l'applicazione di strumentazioni ICT e di tecnologie digitali di tipo innovativo (tra cui sensoristica, fibra ottica, big data mining etc.). Questo dimostra come il termine sia ormai ancorato definitivamente ad una componente tecnologica digitale. Più raramente si assiste all'implementazione di tecnologie innovative di altro genere, come le tecnologie abilitanti KET (Key Enabling Technologies), che

includono ad esempio: biotecnologie, fotonica, materiali avanzati, microelettronica, nanoelettronica, nanotecnologie e sistemi di fabbricazione avanzati. L'applicazione di tali innovazioni, pur rientrando all'interno delle innovazioni tecnologiche, sembra meno diffusa e ancora in una fase di test.

- La presenza di una strategia di trasformazione urbana basata su una chiara visione di partenza, unita ad un forte ruolo di indirizzo nazionale oppure locale, è generalmente un elemento di successo delle strategie, insieme alla definizione di programmi di sviluppo a lungo termine.

- La compresenza di una strategia di reale coinvolgimento cittadino e di stakeholder costituisce anch'essa un importante elemento di successo.

- Molti progetti includono, nelle strategie smart, azioni volte alla costituzione di territori ad alta vocazione culturale e creativa. Questo si registra sia in alcune città europee che in diversi quartieri italiani, che vedono, nell'importante presenza del patrimonio storico e artistico, un elemento trainante lo sviluppo.

Le linee guida progettuali e le azioni intraprese non appaiono così lontane da alcune linee di pensiero che la progettazione urbana degli anni '50-60 metteva in risalto (si vedano ad esempio gli esperimenti sulla partecipazione di G. de Carlo, le riflessioni di L. Quaroni su città e territorio, di S. Salvatori sui centri storici, di K. Lynch sulla percezione dello spazio urbano, etc.).

Main source / *Principale fonte bibliografica di riferimento*:

The main sources allowing reflections included into this chapter are many and mainly they are European case studies documents and reports. Nevertheless, one of the main books contributing to the formation of a critical approach about technologies and cases has been the following.

Le fonti bibliografiche che hanno permesso la stesura del capitolo sono state prevalentemente report e documenti descrittivi i casi studio: documenti di indirizzo, report europei, etc. Tuttavia alcuni volumi hanno permesso una riflessione generale che ha portato, poi, alla definizione di un approccio critico all'analisi dei casi.

Carlo Ratti, Architettura Open Source. Verso una progettazione aperta, Einaudi Editore, Torino, 2014

Directorate-General for internal policies- European Parliament, Mapping Smart Cities in the EU, European Commission, 2014, available at: http://www.europarl.europa.eu/RegData/etudes/etudes/join/2014/507480/IPOL-ITRE_ET(2014)507480_EN.pdf

Keywords: case studies, interpretation of key facts, urban design and planning, smart city, green city

CHAPTER 3:

Cities indexes and models. A key performance approach
Modelli e strumenti di indicizzazione e valutazione. Un approccio basato su indicatori di performance

Abstract / *Sommario*:

The multiplicity of approaches in applying SC strategies inside real urban contexts, analysed in chapter 2, pushed the research in reflecting about the evaluation in time (medium, short and long) of that solutions. In fact, several instruments act in this direction: from rankings and reward programs of most virtuous cities (e.g. the Italian ICityRate or Smart City Index), to certification tools and rating (e.g. LEED, CASBEE, GBC), till international awards (e.g. Green European Cities or 100 Resilient Cities). All of them include, inside their participation processes, several indicators and assessment instruments.

This chapter aims to analyse and study some of the main spread instruments with the aim of identifying the most used and effective indicators of performance for addressing smart, green and resilient processes.

This analysis has been conducted on a selection of 21 models, divided into *ex ante* and *ex post* and into integrated models, rating and ranking instruments, certification tools, awards, European projects. Instruments have been analysed through the use of worksheets.

La molteplicità di approcci nell'applicazione delle strategie SC all'interno delle realtà urbane analizzate nel capitolo 2, ha spinto la ricerca ad interrogarsi su come tali applicazioni vengano valutate, misurate e monitorate nel medio-lungo termine. Molti strumenti agiscono in questo senso: dai ranking che ordinano e premiano le città più virtuose (ad esempio l'italiano ICityRate o Smart City Index), agli strumenti di certificazione (ad es. LEED, CASBEE, GBC), fino agli iter di applicazione di concorsi internazionali (come il label Green European Cities, o 100 Resilient Cities) che contengono, all'interno dei documenti di applicazione stessi, indicatori di valutazione.

Nel capitolo si analizzano i più diffusi strumenti al fine di identificare quali siano gli indicatori più opportuni per indirizzare, in una logica ex ante, i progetti di città Green (sostenibili, resilienti e smart) ma anche di monitorare i risultati nel medio e lungo termine.

L'analisi è stata condotta sulla base di una selezione di 21 strumenti, suddivisi in strumenti ex ante ed ex post, a loro volta suddivisi in modelli integrati, ranking, strumenti di certificazione, label/programmi e network internazionali, progetti europei. Gli strumenti sono stati analizzati attraverso l'ausilio di una schedatura,

riportata alla fine del capitolo.

Main results / *Risultati principali*:

This analysis led to the identification of some lacks into the current implementation practises. In particular, it is possible to observe how the proliferation of such instruments is not going into the direction of creating integrated objectives, but it is evident how each instrument is targeted to a partial description of urban layers/aspects: for example resilience instruments hardly analyses also sustainability or smartness and vice versa.

The research focuses, as a consequence, on the objective of going toward the fulfilment and this lack, by developing a set of indicators able to meet several challenges in the same time. To achieve that objective, some reflections upon urban performance new requirements have been done.

The main chapter result and, more generally, the main result of Section 1, is the selection of a 11 KPIs set, targeted to describe and addressing action toward Green urban planning system, where with Green the research intends an integrated approach among smartness, resilience and energy efficiency.

L'analisi dei modelli ha portato all'identificazione di alcune lacune. In particolare si osserva come la proliferazione di strumenti non stia avvenendo in una logica di integrazione di obiettivi. Ogni strumento è indirizzato a descrivere un unico aspetto della città: gli strumenti di resilienza, ad esempio, difficilmente valutano anche l'efficienza energetica dell'ambiente costruito, viceversa gli strumenti definiti smart non sempre valutano la resilienza, e così via. Questo produce una descrizione parziale dei contesti urbani. La ricerca si è dunque focalizzata sull'obiettivo di colmare tale lacuna, analizzando i requisiti prestazionali di cui un sistema urbano necessita e proponendo una serie di indicatori integrati e comprensivi di vari aspetti urbani: resilienza, tecnologia, sostenibilità ambientale, efficienza energetica, etc.

Il risultato principale del capitolo e, più in generale, della Sezione 1 è stata, dunque, la selezione di un insieme di 11 indicatori, volti alla descrizione e all'indirizzo di una progettazione urbana Green, dove con questo termine, la ricerca intende indicare una visione integrata tra smartness, resilienza ed efficienza energetica.

Main source / *Principale fonte bibliografica di riferimento*:

Besides the sources related to the analysed instruments and models, some books have been of particular interest into the definition of indicators. For its comprehensiveness the following is considered in high consideration:

Oltre ai documenti relativi alle descrizioni dei vari strumenti, alcuni volumi sono stati particolarmente utilizzati nella definizione degli indicatori, tra questi *ricordiamo per la sua completezza il seguente:*

Erell, E., Pearlmutter, D., & Williamson, T., Urban microclimate. Designing the spaces between buildings, Earthscan, London, Washington, DC, 2011

Keywords: key performance indicators (KPI), green cities, ranking, rating, model, strategies, urban regeneration

CONCLUSIONS OF SECTION 1:
CONCLUSIONI DELLA SEZIONE 1:

Abstract / *Sommario*:

The conclusion of section 1 puts in evidence some important aspects coming from the reflexion upon the first three chapters:

1) at first a draft of a first selection of KPIs, composing the Green City Circle (chapter 4), is outlined on the basis of the analysis, both of case studies (chapter 2) and KPI models (chapter 3), but also on the basis of the analysis of current urban needs.

2) secondly, the choice of applying the Green City Circle at the district level is explained;

3) third, a reflexion upon the extension of the Smart City definition into a wider definition including green and resilient aspects is provided.

La conclusione della sezione 1 mette in evidenza alcuni aspetti importanti, che derivano da una riflessione condotta sugli argomenti trattati nei tre capitoli precedenti:

1) in primo luogo viene delineata la scelta degli indicatori principali che compongono il modello Green City Circle, proposto nel capitolo 4. Tale scelta di indicatori si basa, non solo sull'analisi dei modelli (apitolo 3) e dei casi studio (capitolo 2), ma anche su una riflessione a proposito delle necessità dei contesti urbani attuali.

2) in secondo luogo viene delineata la scelta del quartiere come scala intermedia tra quella dell'edificio e della città nel suo complesso e come scala di applicazione privilegiata del modello proposto nel capitolo 4.

3) infine, viene ripreso e spiegato il concetto di "estensione" della definizione di Smart City, verso un approccio più ampio che includa le definizioni di Green City e Resilient City.

CHAPTER 4:
Green City Circle. KPI-based model for built environment regeneration

Green City Circle. Un modello basato su KPI per la rigenerazione dell'ambiente costruito

Abstract / *Sommario*:

The analysis developed into the research highlighted several important elements. At first, several success factors for smart cities have been evidenced from the analysis of European framework documents and reports and from the analysis of real case studies. Secondly, some performance indicators have also been identified and analysed on the base of a reflection about new urban needs. Chapter 4 describes the main original contribution of this research into the debate: a model based on KPIs (Key Performance Indicators) and on a step-by-step approach, aiming to simplify and make more efficient the design process into existent urban districts. The model is divided into five steps each making an advance into the process of implementing urban strategies, at the district scale. The model is divided into the following stages:

1) Situation analysis by using two sets of KPIs.

2) Target and learning step. The target selection is supported by the Target Checklist (see Attachments), which allows the reflection upon the identification of urban stresses.

3) Scenario definition. The same KPIs used for the analysis phase, are here also used for defining and assessing different scenarios of urban future. The result of this phase is a comparative approach among several scenarios composed by different actions.

4) The forth phase proposes the definition of an implementation plan, with a reflection about several key elements, such as business models, stakeholders involvement and timing approach.

5) The last phase consists into the definition of a monitoring and evaluation plan on the perspective of a medium term analysis.

L'analisi fin qui condotta ha messo in luce alcuni elementi importanti. In primo luogo sono stati evidenziati alcuni fattori di successo di una città proiettata verso un futuro intelligente e sostenibile, che derivano sia dall'analisi di documenti programmatici della Commissione Europea, sia dall'analisi di casi studio reali. In secondo luogo, sono stati analizzati e definiti alcuni indicatori di performance, sulla base di una riflessione sul tema dei requisiti dei sistemi urbani. Il capitolo 4 descrive il principale contributo di originalità della ricerca: un modello basato su KPI (Key Performance Indicators) e su un approccio step-by-step, mirato a semplificare e rendere più efficiente il processo di progettazione nei quartieri urbani. Il modello si

esplicita come strumento step-by-step suddiviso in più sezioni, ognuna delle quali costituisce uno stato di avanzamento nel definire ed implementare le strategie urbane, alla scala del quartiere. Il modello si suddivide, dunque, in:

1) Fase di analisi della situazione iniziale, da eseguirsi attraverso l'utilizzo dei KPI.

2) Fase di selezione dei target nel medio termine e di ricerca di situazioni analoghe. La selezione dei target è coadiuvata dalla Scheda dei Target (vedi appendice), che permette di identificare in maniera semplificata alcuni degli stress che il quartiere presenta e di individuare di conseguenza obiettivi di resilienza e sostenibilità nel medio termine.

3) Fase di definizione degli scenari. Gli stessi KPI individuati nella fase di analisi vengono qui utilizzati per definire una serie di scenari alternativi. L'esito di questa fase è la comparazione tra scenari diversi, formati da sistemi di azioni diversi.

4) Fase di definizione della strategia da implementare nel contesto, attraverso analisi costi-benefici, coinvolgimento dei necessari stakeholder e definizione di un approccio temporale.

5) Fase di monitoraggio dei risultati nel medio termine e di valutazione del progetto.

Main results / *Risultati principali*:

The main result of this chapter is the proposition of an integrated model for supporting and accelerating the design of green, smart and resilient existing urban district. The name of the model is selected in Green City Circle.

Il principale risultato è costituito dalla costruzione di un modello integrato di ausilio alla progettazione di quartieri Green, chiamato Green City Circle.

Keywords: design model, Green City Circle, integrated model, step-by-step, scenario, target

CHAPTER 5:

Bolognina neighbourhood. Simulation of the Green City Circle

Il quartiere Bolognina. Simulazione del Green City Circle

Abstract / *Sommario*:

The definition of the Green City Circle model allowed the identification of a set of KPIs useful for the description both of the situation analysis and of building alternative scenarios. The proposed model has been simulated on a real case, selected in collaboration with the Municipality of Bologna, in the Bolognina district. The city of Bologna is of relevant interest as it is involved in several urban regeneration processes and the political and public commitment is high in making

the city sustainable and low-carbon.

The Bolognina district is, in addition, interesting for its position as it is located near the main train station, which links international and national transport systems, but also near the historical city centre, making the district an interesting pilot case. Hence, it is the location of the new City Hall building. Into this context, the simulation of the model has been done through the completion of each steps of the model.

La definizione del modello Green City Circle ha permesso di individuare una serie di indicatori di performance utili non solo alla descrizione degli stati di fatto, ma anche alla costruzione di scenari alternativi, in cui simulare sistemi di azioni diversi in un contesto. Il modello proposto è stato quindi simulato all'interno di un caso reale, individuato in una porzione del quartiere Bolognina, nella città di Bologna.

La città di Bologna appare di rilevante interesse in quanto si sta confrontando da tempo con le tematiche della rigenerazione urbana e della resilienza. Molte azioni sono in corso di sviluppo, a partire dalla pianificazione strategica, fino all'individuazione di aree pilota in cui testare soluzioni innovative. La presenza di uno snodo ferroviario importante per il nord-Italia, dell'aeroporto, di un centro storico di notevole rilevanza, nonché di una vivace comunità produttiva e creativa, rendono la città un luogo di simulazione e test interessante.

Il quartiere della Bolognina incarna, poi, molti di questi elementi, in quanto si trova in prossimità della stazione ferroviaria, è sede del nuovo edificio comunale e possiede una storia industriale importante. In questo contesto, l'applicazione del modello si è esplicitata in primo luogo nello studio dello stato attuale, secondo il set di KPI individuati. In seguito, si sono definiti due scenari alternativi d'intervento: il primo si è concentrato sul tema della fuel poverty e su azioni concentrate sugli edifici, mentre il secondo si è incentrato sul tema del comfort urbano, con interventi sugli spazi aperti e sugli spazi interstiziali. La strategia risultante è stata selezionata riflettendo su quali azioni potessero innescare naturalmente circoli di comportamento virtuosi negli utilizzatori finali ed ha, infatti, visto lo sviluppo di una strategia comprendente azioni di entrambi gli scenari simulati. Lo sviluppo della strategia è stata, inoltre, supportato dalla realizzazione di un'osservazione partecipante, durata circa 2 mesi, all'interno del quartiere stesso, nonché dalla redazione di interviste. Con "osservazione partecipante" si intende una metodologia di indagine sociologica volta ad analizzare un gruppo di persone/una società all'interno di un contesto fisico limitato (si veda Annex II.1 a pagina 334).

Main results / *Risultati principali*:

The main results obtained with the simulation of the model on the context of Bolognina, can be resumed as following:

- model test and identification of strengths and weaknesses. In particular, some barriers have been identified in data availability and in the calculation of some indicators. These weaknesses have, in consequence, led to some modification of the model.

- definition of some recommendations for the municipality of Bologna in light of the development of strategies for the Bolognina context and the identification of some priorities.

I principali risultati ottenuti, con la simulazione del modello, all'interno del contesto della Bolognina, sono stati i seguenti:

- Test del modello e identificazione di punti di forza e di punti deboli. Questi ultimi hanno riguardato, in particolare, l'eventuale difficoltà nel reperimento di alcuni dati e nel calcolo di alcuni indicatori. Questi punti deboli hanno, di conseguenza, permesso di apportare alcune modifiche al modello stesso.

- Definizione di alcune raccomandazioni per lo sviluppo di strategie, nel contesto della Bolognina, con l'identificazione di alcuni assi di intervento prioritari.

Keywords: Bolognina, città metropolitana

CONCLUSIONS OF SECTION 2:
CONCLUSIONI DELLA SEZIONE 2:

Abstract / *Sommario*:

The conclusion of Section 2 puts in evidence some important aspects coming fron the reflection about the Green City Circle simulation:

1) at first, some guidelines and recommendations are provided for the Bolognina district, with the aim of proposing some prioritary axes of intervention;

2) secondly, an analysis of replicability potentials and barriers for the application of the Green City Circle in other urban districts in Bologna, as well as in other cities in Europe, is also provided.

La conclusione della sezione 2 intende mettere in luce alcuni aspetti importanti della simulazione del modello Green City Circle nel contesto del quartiere Bolognina:

1) proposizione di alcune linee guida di intervento per il quartiere selezionato, con la proposizione di assi prioritari di intervento;

2) analisi delle potenzialità di replicabilità del modello in altri quartieri della città di Bologna e analisi delle barriere.

DISCUSSION
DISCUSSIONE

Abstract / *Sommario*:

The research conducted in Section 1 and the simulation of the Green City Circle, in Section 2, allowed to pursue some reflexions in the Discussion section:

- the identification of main research results;
- reflexions about the first research questions addressing at the beginning the whole research;
- reflexions about the use of the model and its sustainability;
- reflexions about research implication and future research proposition.

A seguito della stesura della ricerca e a seguito della simulazione del modello Green City Circle, alcune riflessioni sono state portate avanti:

- *identificazione dei risultati principali della ricerca;*
- *riflessione sulle premesse e sulle domande che avevano indirizzato inizialmente il lavoro;*
- *riflessione sull'integrazione del modello all'interno degli attuali strumenti di pianificazione urbana;*
- *implicazioni della ricerca ed indicazioni sul proseguimento della stessa nel futuro.*

Main results / *Risultati principali*:

The main results the research obtained can be resumed as following:

- At first the research pursued a reflexion about the SC topic trying to overcome the boundaries given by the definition and trying to analyse in a wider perspective of urban dynamics below SC implementation strategies. Through this analysis, several common elements have been identified and compared with other urban definitions and topics linked with sustainability, resilience, energy, ecology, green dynamics. This analysis led to the identification of additional common factors composing a wider definition of city's future perspective, included into a definition of Green City composed by smartness, resilience and sustainability.

- Secondly, the research followes a reflexion about urban systems' needs, by going beyond the building scale in order to meet the district one. The outcome of that analysis, pursued through mapping case studies and KPI models, has been the identification of a panel of quantitative and qualitative KPIs aiming to describe current situation and useful for the composition of alternative scenarios of development.

- Then, the research produced, as the main original contribution, a design instrument based on steps and KPIs.

- Finally, the research applied the Green City Circle on a real context. This simulation, developed on the Bolognina district (Bologna, IT), gave several information about the model in itself but also about the district, giving the possibility to draft guidelines for the municipality of Bologna.

I principali risultati che si ritiene la ricerca abbia raggiunto sono i seguenti.

- una riflessione sul tema della città smart tesa ad analizzare le dinamiche di modificazione urbana in relazione all'evoluzione tecnologica e alle esigenze di sostenibilità e di inclusione sociale. In questo modo, sono stati individuati gli elementi di sviluppo ricorrenti nelle definizioni e nelle applicazioni delle strategie smart e sono stati confrontati con tematiche affini (resilienza, efficientamento energetico, sostenibilità, ecc.). Tale analisi ha permesso di identificare alcuni elementi invarianti che sembrano costituire un approccio al tema urbano più ampio, integrato e multi-disciplinare, che è stato chiamato Green City.

- In secondo luogo la ricerca ha portato avanti una riflessione sui requisiti prestazionali dei sistemi urbani, trascendendo la scala dell'edificio, per arrivare a quella del quartiere. L'esito di tale analisi, che ha visto la mappatura di alcuni modelli e strumenti di descrizione delle prestazioni urbane, ha portato all'identificazione di un set di indicatori utili, non solo a descrivere (qualitativamente e quantitativamente) uno stato di fatto, ma anche ad indirizzare il progetto attraverso la simulazione di scenari alternativi.

- Quindi, la ricerca ha prodotto, come elemento di originalità e come raccordo tra ricerca e applicazione, uno strumento di progetto che ha riassunto in se stesso i risultati precedentemente delineati.

- Infine, la simulazione dello strumento, nel contesto della Bolognina, ha permesso di confrontarsi con una realtà locale reale, che ha fornito elementi di approfondimento e modifica del modello stesso. L'esito di questa fase è stata la redazione di linee guida per il progetto nel quartiere, nonché una riflessione sul potenziale di replicabilità del modello e sulla sua integrabilità nel contesto degli strumenti urbani attuali.

List of abbreviations

BEMS	Building Energy Management Systems
BIM	Building Information Modelling
DPSIR	Driving force – pressure – state – impact – response
EEA	European Environmental Agency
EIT	European Institute of Innovation and Technology
EV	Electric vehicle
EU	Europena Union
GC	Green City
GCC	Green City Circle
GHG	Greenhouse gas
H2020	Horizon 2020
ICT	Information and Communication Technologies
KIC	Knowledge and Innovation Community
KETs	Key Enabling Technologies
KPI	Key Performance Indicators
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
LSE	London School of Economic
NCE	New Climate Economy
OECD	Organisation for Economic Co-operation and Development
PA	Public Administration
PMV	Predicted Mean Vote
RCP	Representative Concentration Pathaways
RES	Renewable Energy Sources
SC	Smart City
SCs	Smart Cities
SCC	Smart Cities and Communities
SMART	(Acronym) Specific, Measurable, Assignable, Realistic, Time-related
SMEs	Small and Medium Entreprises

SSP	Shared socio-economic pathways
ToA	Technology of Architecture
TRL	Technology Readiness Level
UNIBO	University of Bologna
WP	Work Program

SECTION 1

1 Understanding Smart Cities. From theoretical approach to drivers analysis

Nowadays a few numbers of discussions are focused on the topic of Smart Cities. The international debate is aware of the urgent need to better understand the role of cities and their evolution into the future, in order to encounter the increasing and pressing of actual issues (M. Batty et al., 2012; European Environment Agency, 2012; Mandl & Kuttner, 2014; Manitiu & Pedrini, 2015).

Before the research goes into details concerning smart cities[1] approaches and strategies, a frame of the context is essential. Therefore, this chapter content is the review of the most relevant references for the study of the SC. It is divided in three parts.

The first part of the chapter highlights the problem as a result of specific technical, social and economic trends that occurred in all European cities since the XIX century. This section aims to answer the following questions: where and why this topic was born and developed, and what are the main influences and future perspectives? Then, it elaborates the relevance of the topic for sustainable urban development, into the European (EU) urban context, and, in particular, the relevance of the topic for built environment regeneration. The first part also outlines the definition of "what" SC actually means by giving a critical review of the most accepted definitions. To achieve this goal, the different terms, occurring in the field, are considered and evaluated as an evolution of the topic through

1 From this moment on the word Smart City will be shorten with SC and Smart Cities with SCs.

a qualitative literature review. Moreover, for a higher comprehension of the subject, a brief definition analysis is provided as a critical instrument for further development of the research.

In order to deeply understand the concept, the second part of the work analyses the driving forces of the matter: climate changes, that all contemporary cities have to take in high consideration; challenges linked with the increasing urbanization and population trends; land use, urban sprawl and resilience[2]; finally an overview of city's technological infrastructure aiming at understanding the increasing trend of Information and Communication Technologies (ICT) and digital technology implementation is provided.

The third and final part highlights current legislations and directives as instruments able to make the topic applicable into a real context: from Europe 2050 strategies and directives toward an Italian regulation framework overview.

The research is further supported by Annexes and Attachements where materials collected for defining the presented research are reported.

2 see Glossary-Urban sprawl and land use, p. 23 and see Glossary-Resilience, p. 22.

1.1 Smart City vision

1.1.1 Framing the problem of Smart Cities into the Anthropocene age

The SC issue has a social, economic and technical importance. As argued by many authors we are nowadays in a transition period of evolution where cities are seen as a key point of change (M. Batty et al., 2012; Bonomi & Masiero, 2014; Hajer & Dassen, 2014; Secchi, 2013). As defined by the EU in last years (Espon, 2012; European Commission Directorate General, 2015; EEA, 2017), cities are the key stones of European well-being as economic strength, wealth and social opportunities for the future[1]. The growing of population is, in fact, increasing year-by-year the urban density, leading to the exacerbation of challenges related to sustainability and to urban management. Then, waste management, energetic demand peak, traffic congestion, air and water pollutions, lack of identity, fuel poverty are just some of the main problems asking cities to find solutions on a long term perspective (IPCC, 2013; Richardson, 2012). Indeed, between the challenges, some specific elements are conceived of particular interest for this research:

- the addressing role of European decrees -2010/31/EU- (Econometrics & Garden, 2013; Parlamento Europeo, 2010, 2012), imposing a substantial reduction of emissions (20% before 2020 and 40% before 2030) and an overall improvement of environmental and energetic urban conditions;

- the pressure of the global market that, despite the general crisis, continuously proposes new ICT technologies and devices for citizens' life and cities;

- the presence of obsolete buildings and neighbourhoods, causing challenges and problems not only from an energetic point of view, but also for security, network management, mobility issues, resource management, indoor/outdoor comfort risk management and fuel poverty;

- the functionalization of districts and urban sprawl, result of last century planning system, which have produced so-called "dormitory" suburbs, empty during the day, because of the commuters' conditions of the population;

- the constant and growing use of land exarcebating sprawl, land use and resource depletion and worsing climate conditions;

- the constant rising of resources demand, linked with the increasing of

1 See also the Sustainable Agenda defined by United Nations, 2015.

population, urbanization and energy consuming fuel-based heating and cooling systems;

- the computerization of society, slightly predictable and controllable, which allows a social life in close contact, through the spread use of social networks, which overcomes physical barriers and changes uses of urban spaces (Wolfram, 2012).

In between these challenges, **mitigation and adaptation to climate changes** are seen as some of the most challenging issues (IPCC, 2013; Matzarakis, Georgiadis, & Rossi, 2007; Santamouris, 2016; Wolfram, 2012; EEA, 2017), as an effective transition toward low-carbon cities is more and more urgent, being the actual cities' urban metabolism approaching the non-return level point[2] . The lack of such a transition is expected to lead cities in increasing problems, such as social, financial, maintenance and fragility risks (European Commission Directorate General, 2015; Hajer & Dassen, 2014; EEA, 2017), as well as natural and environmental risks too (Espon, 2013; EEa, 2017). In fact, actual era is defined as "Anthropocene[3] epoch" by different authors. According to Crutzen studies, the human lifestyle based on fuelled systems and on the large use of non-renewable resources, is having geological impacts on the Earth environment, from the end of XVIII century (Crutzen, 2006; Steffen, Crutzen, & McNeill, 2007)[4]. Into this definition, cities are concerned in a relevant way as well as the built environment inside them beacause, as set by the EU into the Directive 31/2010, buildings are responsible of 40% of total energy consumption and of one third of total greenhouse gas emissions (GHG) and cities are responsible of 70%, as defined by the GHG protocol (UNEP SBCI, 2009; ICLEI, 2014). As a consequence, the EU Directives 31/2010 and 27/2012 set the need to improve, at least, up to 20% the building performances before 2020 and better (the New Covenant of Major set the target of 40% before 2030) before 2050[5] (Parlamento Europeo, 2010, 2012). Furthermore, the Sustainable Agenda created by the United Nations (United Nations, 2015) highlights how cities are among the 17 major goals' areas where

2 see Glossary-Urban metabolism, p. 23.

3 The definition ascends from the Nobel Prize in Chemistry Paul Crutzen, who defined the actual contemporary era with this name due to the impact that industrial life-style has into the environment.

4 see Glossary-Anthropocene era, p. 18.

5 For an overview of EU framework and strategies toward 2050, as well as for the Italian framework, see paragraph 1.3, p. 88

target need to be achieved before 2030, in order to become more sustainable and resilient to climate change[6]. Hence, cities are seen as important fields of intervention, where the answer for more sustainable and resilient systems can be met. Besides, cities are also the context for innovation application: the necessity of making them more sustainable and efficient leads to the implementation of several technologies and enablers (both ICT or not), putting the city at the centre of the debate about technological implementation and urban evolution[7].

Thus, the SC appears as one of the possible answers for meeting these challenges (AA.VV., 2013; Caragliu et al., 2011; Paroutis, Bennett, & Heracleous, 2013). In fact, the birth of the topic in the XIX century, seems to be strictly related with the awareness of sustainability, overlapping some of the most important summits on energy and sustainability, and with some reflections about social, economic, environment crisis (see Annex I.1). In fact, this increased attention into the discourse of sustainability, as one of the main target to be addressed, starts to be evaluated from the United Nations Stockholm Conference on the Human Environment of 1972. During the conference, a declaration on environmental issues and on international cooperation was signed by several mandatories. From this conference, several other important meetings set the urgency of acting

6 Inside the definition of city as one of the 17 major goals, the report focuses on tasks that cities need to meet. These tasks are nine and defined as following: 1)to ensure access for all to adequate, safe and affordable housing and basic services; 2) to provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety and making the transport system accessible for all; 3) To protect and enhance the cultural and natural heritage; 4) by 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations; 5) by 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management; 6) by 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities; 7) support positive economic, social and environmental links between urban, per-urban and rural areas by strengthening national and regional development planning; 8) by 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels; 9) support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials (United Nations, 2015).

7 Even if in the following paragraph the definition of SC is analysed in detail, it is currently assumed the strong link among SC and technological application.

against climate change. Indeed, the concept of sustainability has been seen for the first time in 1987 into the Brundtland Report, made by the World Commision on Environment and Development. Following the studies of (Daly, 1991), the conditions for real sustainability can be summed as following:

- the consumption of resources may not overload their regeneration potential;
- the consumption of non renewables resources may not overcome the time for finding these resources or the time for developing alternatives or substitutive resources;
- the pollutants' emissions may not overcome the environment absorption capacity.

These are the main three guidelines that may lead the development of resources consumption and, consequently, the development of policies. These factors were defined and actualized during several international meeting on climate change and on sustainability (for a summary table of these main moments, see Annex I.1, p. 326).

1.1.2 Consideration for a common definition: from Smart to Green Cities

The over-use of the term SC into the recent debate obliges to make observations upon the definition associated with SC concept. A preliminary reflection on terminological questions is needed to understand the research approach and the field of interest delimitation, as well as to understand the common uses of this terminology.

The concept of SC emerged in the late 1990's in response to the rising concerns about the impact of human practises on the environment, about cities' energetic consumptions, land use and about technological growing. There is no sure evidence of where and when exactly the word smart starts to be associated with city. The debate seems to take the incentive during the 1980's and 1990's from the reflections about urban evolution, and probably from the observation of High-Tech cities, industrial growth and from the general increasing role of technology. Among the authors giving a specific point of view and a boost on the theme analysis, a great influence is given by Peter Hall[8] with the reflexions on technologies application on urban context evident in metropolitan cities in

8 For a complete analysis of these themes see Cities of tomorrow, Peter Hall, 1996 and the other publications (Buck, Gordon, Hall, & Kleinman, 2002; P. Hall & Castells, 1994; P. Hall & Pfeiffer, 2000; P. Hall, 1996, 2013; R. E. Hall, Bowerman, Braverman, Taylor, & Todosow, 2000).

Europe and America (P. Hall, 1996). His analysis about cities' evolution is centred into the reflection on the role of technology for boosting urban development[9] and on scenarios of future cities into the contemporary age. In the meantime, other scientists as Nicos Komninos, Michael Batty, Mark Deakin, Leonidas Anthopoulos, Carlo Ratti et al. (N. Komninos & Sefertzi, 1998; N. Komninos, 2006) were reflecting on the role of industrialization and technologies applied to cities and peripheries, on the importance of social science and citizens' wellbeing into the urban life, as specific and new key points for urbanism. In addition, other architects and urban planners from Le Corbusier, at first, to Aldo Rossi and Rem Koolhas, later, were reflecting about cities and urban development[10]. It is probably during this reflective periods, on all XX century, that the SC topic has its precursors and the proper background for its development.

Actual, there are several definitions of the concept SC. In fact the word can own different connotations depending on the field of application (Nam & Pardo, 2011). From the early 2000's, different authors have tried to define the topic in different ways, aiming to highlight features and key points. Therefore, a common definition is still not present into the international debate, even if some important achievements have been accomplished. Each organisation, research centre, scientist, involved into the analysis of SC, tends to propose a personal definition of the topic. As a general guideline, each definition highlights in some way the specific field of interest of the proponent. So, for example, a social scientist tends to highlight citizens' involvement on SC and recognise, as the main aim of smart strategies, people behaviour, social inclusion and growth, participation of citizens into public decisions making, etc. Alternatively, an electrical engineer will focus more on the role of smart grids to foster the development of urban context, on the role of renewable to reduce urban energy consumption, and so on .

Moreover, the locution SC seems to be born in the late 1980's in the USA associated at first to *growth* instead of to city. The term *smart growth* was used to indicate a specific planning methodology for residential districts that considered necessary a reduction of urban expansion in order to avoid excessive land uses and urban sprawl. The smart growth planning was based on different key elements:

9 For the analysis of Peter Hall studies on smart cities and long waves see the studies of Michael Batty, 2015 (Michael Batty, 2015).

10 As an example, see: Le Corbusier projects for the Ville Radieuse, 1930; Aldo Rossi, L'architettura della città, Padova, Marsilio 1966; Rem Koolhas, Delirious New York, 1978 (Electa, 2011 new edition)

- a compact and denser districts, where the physical extension and the land use was controlled, limited and the mixed-use of functions was pursued;

- the predominant use of public transport;

- the planning of spaces based on pedestrians and bicycles uses[11] .

From this experience, based on urbanism, urban form and sustainable principles, the locution *smart* starts to be applied to cities in Europe and, step by step, it enters inside European policies (at first into the SET-Plan) and into the international debate.

Authors associates the begin of the smart-brand (considered alone) in 1996 because of the production of an innovative object. The Daimler AG group proposed into the market a small, cheap and technological car, a Smart car. From this idea, the word became a synonym of useful, simple and cheap, as well as a word associated with objects having a different usability (multi-tasking or automatic uses) (Bonomi & Masiero, 2014). Then, it enters more and more into the market and become a "nice to have" characteristic, indicating a kind of intelligent usability, of technological skills of uses' integration and innovation (Bonomi & Masiero, 2014). In 1992, the IBM placed, then, into the market the first mobile *smart phone*. This object integrated in itself additional and different functions: management of personal data, email, games, other programs and apps. From that moment on, this phone was named *smartphone*, because of its efficiency, smallness and multi-functionalities (Bonomi & Masiero, 2014; Dall'O, 2014).

Hence, the use of the word smart is not the first one being associated with city. This practise of adding different adjectives to city is quite recent (it can be considered starting at the end of 1990's) and answers to the necessity of identifying new attributions and descriptions to cities appearing as evolving entities. For example *intelligent* or *cyber* cities (Nicos Komninos, 2011), which indicated the connection of cities with technologies and, in particular, with digital technologies; or *wired* (Hollands, 2008) and *ubiquitous* cities (Anthopoulos & Vakali, 2012), indicating the extension of digital and Internet as enabler of interactions overcoming physical barriers; the more recent *creative* and *sharing* city, highlighting soft components and the role of citizens as prosumers; ending with the new definitions of *porous* city (Secchi & Viganò, 2012) or *extreme* city (Viganò & Fabian, 2010) or recycling city (Fabian, Giannotti, & Viganò, 2012)

11 For an overview of Smart Growth Planning aspects see the website: http://www.smartgrowthamerica.org/what-is-smart-growth

or *senseable* city (Resch, Britter, & Ratti, 2012). It seems that the evolution of those definitions starts from considerations about digital implementation and technology presence inside cities, going toward the identification of a secondary role attributed to technologies in respect of a major one attributed to people or to climate change.

Furthermore, in the English language the word smart is an equivalent for clever, intelligent and sharp, even if the Oxford Dictionary confines it for the colloquial use. Actually, the formal use of smart is generally referred to fashion and dressing (Oxford Dictionnary, 2015).

Thus, if we assume the word smart as an extension of the word intelligent it is possible to analyse the etymology. Intelligent comes from the Latin *intelligentia / intelligere* and means the "*complex of psychic and mental faculties making the mankind able to think, understand or explain facts or actions, to judge*" (Treccani Dictionnary). The intelligence makes the mankind able to adapt to new and coming situations and to modify the same situation when necessary for mankind survivance (Treccani Dictionnary). This definition highlights two important elements:

- the **comprehension/knowledge** related attribute. An intelligent object can think, understand, explain and judge. It means, if the word is applied to cities, that it must be something able to "think" what are the best actions to be addressed into the contest, then "to understand" how these actions are implemented and finally to "evaluate" them in respect of some indicators;

- the **adaptatio**n related attribute. This is the most interesting element, because it means that an intelligent (or smart) city can adapt itself to barriers and adverse conditions. This means also that an intelligent (or smart) city is not a fixed city, but an **evolving entity**.

Moreover, analysing the definition gave by the Treccani vocabulary about SC it is possible to find the following: "*A SC is a city formed by the integration of knowledge, structures and technological advanced systems. These elements are specific of a communication and information society and are finalized to a sustainable growth and to the improvement of quality of life*[12] ". The analysis of

12 Personal translation from the Treccani vocabulary. The original definition is the following: "Città caratterizzata dall'integrazione tra saperi, strutture e mezzi tecnologicamente avanzati, propri della società della comunicazione e dell'informazione, finalizzati a una crescita sostenibile e al miglioramento della qualità della vita."

these definitions is interesting because it gives the dimension of the common knowledge on the topic and of the general non-scientific understanding, as for example also the following: "*A SC function, or digital or intelligent city, is a function of a city that is not satisfied to act as a physical container, but seeking to preside global spaces, including new protagonists and supporting creativity and innovation inside schools and enterprises*". (Renato Mattioni, Corriere della sera, 10 October 2011)[13] . These definitions, even if they are not scientific, highlight some additional important elements:

1. at first the objective of SC is to **improve the urban quality of life** and to address a sustainable growing;

2. the importance of the **global scale** of intervention. The SC is considered as a typology of city acting on a global dimension. The use of ICT technologies, based on the web, leads to overcoming the territorial boundaries, which was the basis of the traditional urbanism.

3. the inclusion of "**new protagonists**". In the scientific production these protagonists are named stakeholders and are considered one of the major elements to be included in smart planning. It is set by several authors that the planning methodology for smart cities must involve different groups of stakeholders: policy makers and municipalities, citizens, enterprises, both small, medium and large[14] (ICLEI, 2014).

Finally, the European Parliament, with the Directorate General for Internal Policies gives the following definition: "*a SC is a city seeking to address public issues via ICT-based solutions on the basis of a multi- stakeholder, municipally based partnership*" (Directorate-General for internal policies- European Parliament, 2014). The EU exposition, which is intended to give a definitive point of view on the term, puts in evidence important aspects:

---

13 Personal translation from the Treccani Vocabulary, citing Renato Mattioni on the newspaper Corriere della Sera. The original definition is: "Una funzione da SC, di città digitale ed intelligente, cioè, che non si accontenta di fare da contenitore fisico, ma che cerca di presidiare gli spazi globali, stanando i nuovi protagonisti, sostenendo creatività ed innovazione dentro le scuole come nelle imprese".

14 A second interesting definition given by the same vocabulary is the definition of Juan Carlos De Martin, appeared into the newspaper Stampa, the 9 March 2012. The definition says: "To talk about SC means to think to the city of the future in an integrated way: environment, people and technology. In this sense, a SC differs form the more technological cousin "digital city", which underlines only the information technology role. Even if the SC is different from the digital city, the last one is necessary for building the first one".

- the objective of the SC is **to address public issues**. It means that the main objective is to improve urban conditions by addressing current problems. This aspect assumes a deep knowledge on that public issues;

- the second element is the **centrality of ICT,** as the major enabler to address those issues;

- finally, the third element is the way for achieving the objective in the **creation of partnerships based on municipality**, as the key leader of development, and by a multiplicity of stakeholders. The role given to the municipality is important. In fact, it is assumed that the SC development is more based on the city dimension (local), rather than on an agglomerated or national dimension (global). This element is crucial because it seems to gives to single municipalities the role of leaders into addressing the change, by choosing actions to be implemented and by judging about results. Into this dimension, the national government can be seen as the responsible for general directives instead of for specific actions definition.

Several other definitions have been analysed into this work and Annex I.2 proposes a summary table giving the evidence of this research (see Annex I.2, p. 328). Among all the used definitions, it is finally possible to find some main trends:

- **technological / digital related definitions**. These definitions see the city as a ground for ICT technology application. These technologies can be addressed for example to services (e.g. technologies for mobility), information (e.g. websites and e-gov), monitoring (e.g. energetic or pollution sensors). These definitions observe the integration of different typologies of ICT technologies into the city as the major driver of change.

- **sustainability/energy related definitions**. These definitions highlight the need for reducing global CO_2 emissions and energetic consumption, on an urban metabolism perspective;

- **creative/learning related definitions**. These definitions tend to highlight a soft or immaterial component of urban systems: the presence of a creative class, aware and sympathetic citizens and/or a politic/leader class able to observe, learn the environment and act in consequence. Therefore the presence of an enabling environment for the development of them is theorized by important scientists such as Alberto Magnaghi and Giacomo Beccattini, with the name of "*coscienza di luogo*" (= awareness of place)[15].

15 see Glossary-Coscienza di luogo, p. 19.

Table 1. 1 Summary of meanings' analysis of smartness

Definitions	**Main elements**
From intelligent etymology	- Comprehension of the real conditions through understanding, explaining, judging - Adaptation. An intelligent city can adapt to external condition and modify itself
From the attributes gave to smart by the market (reference to Smart Car and Smart Phone)	- Simple, user-friendly, ability to answer to different inputs in the best possible way - Useful, simple, cheap and technological - Multi-tasking / automatic use - Integration of several functionalities into the same object
From non-scientific sources (newspapers giving the idea of the general understanding of the topic)	- Integration of knowledge, structures and technological advanced systems - Improvement citizens' quality of life - The finalization of smart city is sustainable growth - The dimension of the smart city is the global dimension. This overcomes the traditional perception of a city linked only with the territorial urban dimension. - Inclusion of stakeholders.
From EU definition	- To address public issues which implies a deep knowledge on local challenges - ICT is an enabler both at global and local scale - To involve a panel of stakeholders under the addressing role assumed by municipality

There is no predominance of one of the selected trends into the actual international debate, because each one evidence a part of the complexity of cities by enhancing the nature of cities as complex systems, composed by several and overlapped layers. In conclusion, it is possible to define some important elements that all those definitions have in common, as key points to be considered.

The first one is that **ICT technology is a trend not necessary linked with the urban contest.** Technology, in fact, responds to market long perspectives and it can be applied to the urban context or it can also exist as a stand-alone object and service. As a consequence, its presence inside the planning phase seems important. A city where ICT technologies are applied in a chaotic (not planned) way can lead to maintenance and management issues as to the proliferation of unefficient and non-integrated sub-systems. Conversely, ICT technologies can produce positive effects on those same elements. For example, if the mobility system is planned with a multi-layered way, it is possible to create a useful network of public vehicles (e.g. buses) linked with information technology (e.g. displays), other public transports (e.g. trains, airplanes) and private cars (e.g. with parking sensors), giving several levels of information to end-users. A non-integrated mobility system can worsen the general service, for example with the incompatibility of information software, with the creation of more traffic congestion or with the creation of delay between the different meanings. The implementation into the urban context of smart technologies can be a driving force for city's development, as the collection and use of big-data, as instrument for observing and reading actual existing contexts (M. Batty, 2013; Michael Batty, 2008; Kitchin, 2014). As an example, devices able to make the heating system, of an urban portion, smarter and more sustainable by heating only buildings where people works (e.g. offices) during the day and residential buildings during the evening and night can drastically reduce the thermal energy demand, without the need for more production; or devices in mobility able to avoid 23h parked cars can make the system more efficient, etc. Lots of devices and instruments can be designed and implemented to really make the system smarter. In fact, different authors look at the technology as a driver able to achieve more equitable, inclusive, efficient and democratic cities (Partridge, McAllister, Hall, & Hallam, 2005; Partridge, McAllister, & Hallam, 2007; Partridge, 2004; Washburn, D., Sindhu, U., Balaouras, S., Dines, R. A., Hayes, N. M., & Nelson, 2010).

The second element is the strict **correlation between citiy and sustainability**. This connection is clearly proved by several studies: cities need to reduce their general footprint; it is not a “nice to have” but it is a “need” for the maintenance of basic human rights (Hajer & Dassen, 2014; European Commission Directorate General for Regional Policy, 2011).

The third element is the importance of **people**, as real and active participants in urban life and in planning decisions. Nowadays, citizens are not anymore conceived as passive actors or end-users but as active decision makers and evaluators of urban space as well as prosumers of services. A few reasons beyond that: the first one relates to the economic/resource crisis and the insertion of product/services into the city. Since there are no unlimited resources and funds, each product or service need to be efficient and effective in order to survive into the market and to really be useful. The city can be evaluated in the same way: if there are un-efficient services people simply won’t use them, preferring others. The mobility case can make this element clearer. If a city implements an innovative public transport in order to reduce traffic congestion and related emissions, and this transport is not efficient, people will not use it, preferring for example private cars. The second one relates to the necessity of creating more liveable and attractive cities both in a competitive dimension with other cities but also on the healthcare perspective (see Interview n°2, p. 366). Greener cities, with best services, welfare, human conditions, best security and social inclusion are preferred. A city able to guarantee these services can increase its economic growth and attract more companies and funds. Planning these kinds of cities requires a deep collaboration with people during all planning phases (both stakeholders and citizens). As well, the presence of an important creative class can boost the economic and social development. Hence, there is an important attention given to cities as experimental environments. According to a big part of the international debate (Directorate-General for internal policies- European Parliament, 2014; Hajer & Dassen, 2014; Papa, Gargiulo, & Battarra, 2016; Resch et al., 2012), this aspect is crucial for the development of more effective urban contexts because having an evolving environment with an active creative class and an integrated society could be a turning point for the real achievement of low-carbon and technological transition.

The set up plan to achieve this goal using the guidelines gave by EU is complex and requires an integrated approach between stakeholders and municipality. From this consideration, there are several researches (GIZ & ICLEI, 2014) highlighting these aspects and pointing the importance of proposing cross-cutting strategies in order to really meet actual urban challenges. The idea is to avoid the so-called silos-thinking which is nowadays the currently used process. The silos-thinking system is linked with different sectors of the urban context (e.g. urbanism, energy, mobility, etc) and their sectorial management. According to these researches, the smartness of a city is, first of all, to avoid this sectorial management, in order to produce an integrated and cross-sectorial process. The city starts to be seen as a complex system where different layers are overlapped (Antonini, Boulanger, & Gaspari, 2015). Actually, the main subdivision of this layers is given by Giffinger et al. in an important study converged into the PLEEC project (Giffinger & Fertner, 2007; Giffinger, Hemis, Weninger, & Haindlmaier, 2014; Giffinger & Strohmayer, 2014). Into this study the SC is defined as following: "*A SC is a city well performing in a forward-looking way in these six characteristics, built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens*" (Giffinger & Fertner, 2007). The six characteristics evidenced in the definition are the following: economy, people, mobility, governance, environment and living. Each of these categories has, in the opinion of the cited study, specific smart characteristics to achieve and with which it is possible to evaluate the urban smartness (Fig. 1.1). The six characteristics outlined by Giffinger are still present and a reference into the international literature and provide a basic subdivision of the smart themes. Into the EU report (Directorate-General for internal policies-European Parliament, 2014) these categories are enhanced and specified into their definition (see Annex I.3, p. 330). It is clear that the categories are a generalization aimed at simplifying planning complexity. However often, cities really present this subdivision of functions inside the administration, which leads the implementation of separated actions inside the territory. Despite the importance of implementing actions in all these categories is recognised, the

Table 1. 2 Summary of the main smart city features

Category	**Description**
Objectives	- To address public challenges - To improve urban quality and citizens life - To increase the sustainability of cities
Way to achieve the objectives	- Partnership between multi-stakeholders and municipality - Cross-cutting strategy (avoid silos-thinking)
Channels for achieving the objectives	- ICT - innovation and innovative technologies
Actors involved	- Municipality as a leader - Citizens as part of the planning phase - Enterprises (big and SMEs)

Figure 1.1 Giffinger's 6 characteristics

SMART ECONOMY
(Competitiveness)

- Innovative spirit
- Entrepreneurship
- Economic image & trademarks
- Productivity
- Flexibility of labour market
- International embeddedness
- *Ability to transform*

SMART PEOPLE
(Social and Human Capital)

- Level of qualification
- Affinity to life long learning
- Social and ethnic plurality
- Flexibility
- Creativity
- Cosmopolitanism/Open-mindedness
- Participation in public life

SMART GOVERNANCE
(Participation)

- Participation in decision-making
- Public and social services
- Transparent governance
- *Political strategies & perspectives*

SMART MOBILITY
(Transport and ICT)

- Local accessibility
- (Inter-)national accessibility
- Availability of ICT-infrastructure
- Sustainable, innovative and safe transport systems

SMART ENVIRONMENT
(Natural resources)

- Attractivity of natural conditions
- Pollution
- Environmental protection
- Sustainable resource management

SMART LIVING
(Quality of life)

- Cultural facilities
- Health conditions
- Individual safety
- Housing quality
- Education facilities
- Touristic attractivity
- Social cohesion

present research finds some gaps and limitations into this frame. First of all, categories are not exhaustive for addressing a holistic urban strategy. Then, the risk to focus too much on this categories addressing actions without considering a cross-sectorial dimension is still high (GIZ & ICLEI, 2014).

In conclusion, it is possible to outline some important key elements allowing a reflection upon the concept of SC.

The first notable element is the **origin of the topic** from two distinct sources:

- the debate on cities evolution. From the end of the XX century, there was a proliferation of urban studies observing that cities were in a phase of evolution, where peripheries were growing and a diffusion of sectorial district development (e.g. commercial, business districts, etc.), with a pressing presence of cars and related infrastructures, were the main elements;

- the dissertation on the sustainability and technology innovation. The analysis of urban evolution goes through the analysis of two important trends: the rising awareness of human load into the environment, and the rising of technology innovations applied in a spread way into people life.

The second important element is that all definitions use the formula "*a SC is a city that...*". This means that the international debate sees the SC as a specific city, or a specific result of a planning methodology. The present research aims to reflect on this element, investigating if rather than being a typology of city, SC can be conceived more as a **process** aiming at achieving specific targets of sustainability, inclusion, safety, resilience and where technology is an enabler in association with other instruments (e.g. participation, cultural heritage, innovation in general, etc.).

The third element that the research aims to highlight is the **objective of the SC discourse**. As set by into the analysis of the current debate, it is reasonable to affirm that SC has the specific objective of addressing societal issues and mainly:

- to address sustainability, by improving the performance of the urban contest conceived as a whole;

- to improve urban quality in order to enhance citizens life and economic growth.

Then, the forth element is the way for achieving these objectives. The analysis outlines the importance of a **systemic approach** on urban contexts avoiding the silos thinking one, with the involvement of several stakeholders in a cross-cutting strategy.

Finally, the literature review emphasizes the presence of several application

Figure 1.2 Relations among university, industry and government into the Helix approach. (Sources: Carayannis et al., 2012)

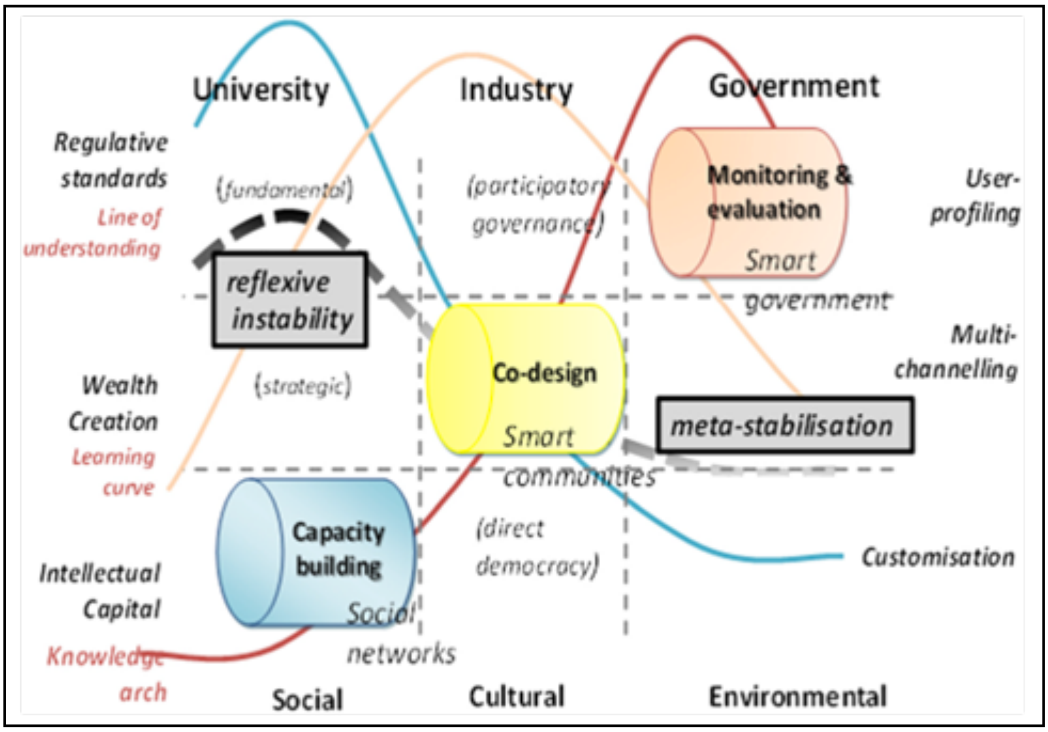
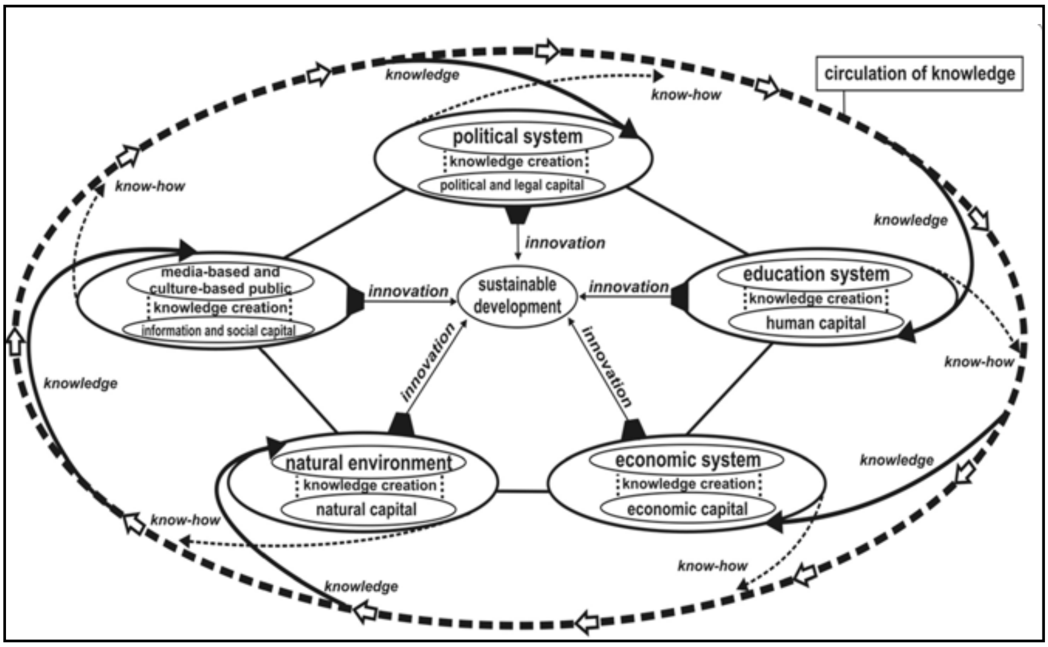


Figure 1.3 Helix approach. Relations among parts. (Sources: Carayannis et al., 2012)



categories for the achievement of urban smartness. The international debate recognises six categories as the main ones, but it is opinion of this research that a deeper understanding of planning methodologies and cross-cutting models is needed . All these highlighted aspects are some of the elements foreseen for the SC development, but still they are not enough to determine a comprehensive and complete strategy or "formula". Hence, even if different research centres and associations are trying to give a definitive definition of the term, the international debate on SC agrees that an existing or ready formula for their construction of still doesn't exist (Caragliu et al., 2011; R. P. Dameri & Cocchia, 2013; Hollands, 2008). It is opinion of authors such as Hajer and Dassen that the SC discourse can help cities to become more efficient and resilient, but there is a need to look to the long term perspective and not to the short one (Espon, 2014; Europea, 2007; Manitiu & Pedrini, 2015).

1.1.3 Helix and stakeholder approach

The current debate about SC is wide and extended to different aspects of urban planning. An important role is assumed by stakeholders' analysis and by a knowledge-based environment definition. This typology of analysis takes the name of Helix Approach. Since the beginning of studies about SC, different scientists came out with an innovative model, named Triple Helix, aiming to focus on the importance of the context where SC is planned. With "context", these scientists means the environment on the cultural, scientific, knowledge and innovation perspective, as well as on the governance point of view. It is, in fact, believed that the success of a SC, and the existence of a smart approach in itself, it is possible only if the context presents a network of collaborative partners composed mainly by universities, industries and government, in order to create an environment of innovation and knowledge (Deakin, 2014; Kourtit et al., 2013; Leydesdorff & Deakin, 2010; Lombardi, Giordano, Farouh, & Yousef, 2012; Santis, Fasano, Mignolli, & Villa, 2012). This could be generated not only by market rules, but moreover by the real collaboration between several stakeholders, e.g. as the research world works in synergy with the production one and with the strategic and holistic view given by the government. The creation of such knowledge, collaborative and innovative-led environment would be able, in opinion of these researches, to generate in consequence wealth (Deakin, 2014; Kourtit et al., 2013). In figure 1.2, it is possible to see how these interrelations are framed.

In last years, the Triple Helix model saw different extensions to the Quadruple and then Quintuple Helix (Carayannis, Barth, & Campbell, 2012; Carayannis & Campbell, 2009, 2012; Leydesdorff, 2010). Into these approaches, there is the extension from the knowledge-based society and the knowledge democracy (quadruple helix) to the social-ecological transition and the environmental-led society (quintuple helix). Into these views, the knowledge is the pivotal for reaching SCs through the involvement of stakeholders (industries, universities and government), of people (through the knowledge democracy) and, finally, of environmental-led societies, able to understand the need for the ecological transition and being able to act in that direction. As defined by Carayannis and Campbell: "*The Quintuple Helix Model is interdisciplinary and trans-disciplinary at the same time: the complexity of the five-helix structure implies that a full analytical understanding of all helices requires the continuous involvement of the whole disciplinary spectrum, ranging from the natural sciences (because of the natural environment) to the social sciences and humanities (because of society, democracy and the economy)*' (Carayannis et al., 2012).

These studies[16] about the Helix approach are of particular interest for a deep comprehension of the social environment needed for the success of actual urban planning and for understanding the complex interrelations needed for making projects feasible. Figure 1.3 explains the functions of each part of the helix.

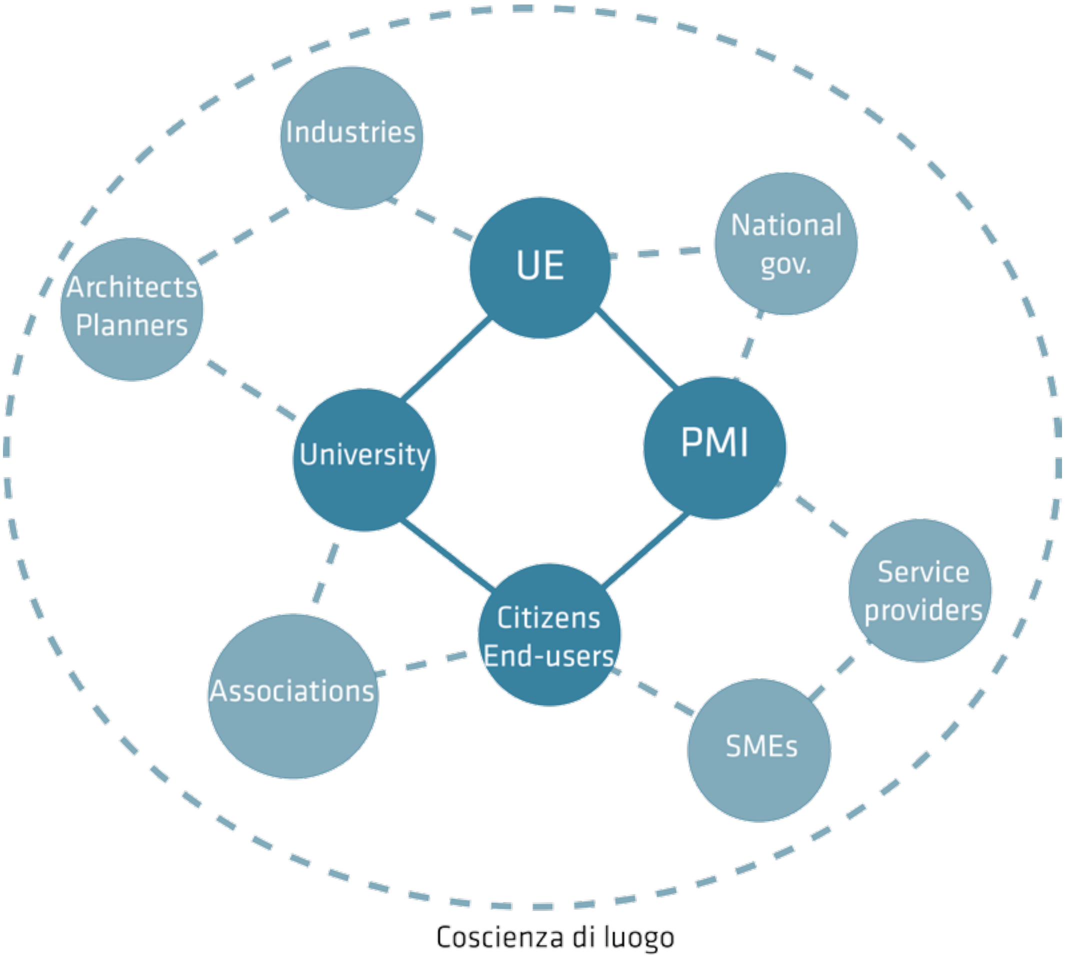
Therefore, the analysis of the best environment able to foster cities' growth is object of a wider debate, going toward SC boundaries. Nevertheless, reflecting not only upon how to implement strategies, but also on how to trigger change after the end of such strategies, is of great interest, in order to guarantee projects long-term sustainability. Indeed, the application of innovative strategies on a territory needs a deep knowledge on the local territory in itself. This means not only to gain knowledge about strenghts, potentialities, weakenesses and barriers, but also about all the substrates composing this territory: socialities, traditions, intrinsic knowledge, people lifestyle and social composition, entrepreneurial mindset, etc. In fact, it is inside this intrinsec complexity that elements for addressing and hold actions can be found. Some scientists call this substrate "coscienza di luogo" (Becattini, 2015).

To sum up on stakeholder approach, it is reasonable to define that SC

16 For more information about this content see the bibliography and mainly the following texts: Carayannis et al., 2012; Carayannis & Campbell, 2009, 2012; Deakin, 2014; Kourtit et al., 2013; Leydesdorff & Deakin, 2010; Leydesdorff, 2010; Lombardi et al., 2012.

strategies need to involve from the beginning a wide panel of stakeholders, but that it also needs to deeply understand the composition and the complexity of territorial substrate in order to hold strategies on a long term perspective. Figure 1.4 gives a personal analysis of possible relations among different stakeholders[17].

Figure 1.4 Stakeholders relations. Personal analysis



17 A scientific publication about stakeholder approach as been done in the Journal Ufficio Tecnico, see: Boulanger Saveria Olga Murielle, La Smart City come processo integrato per lo sviluppo urbano, in Ufficio Tecnico, n°4, anno 2015, ISSN 0394-8293, pp 10-15

Figure 1.5 Temperature change in respect to years (University of Oxford, 2016)

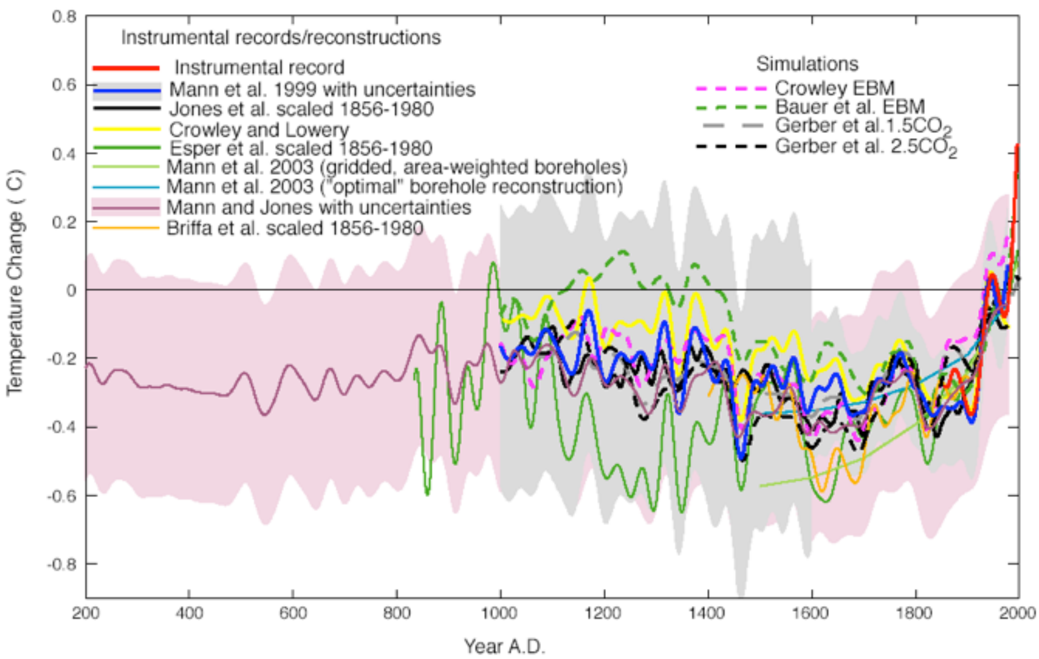
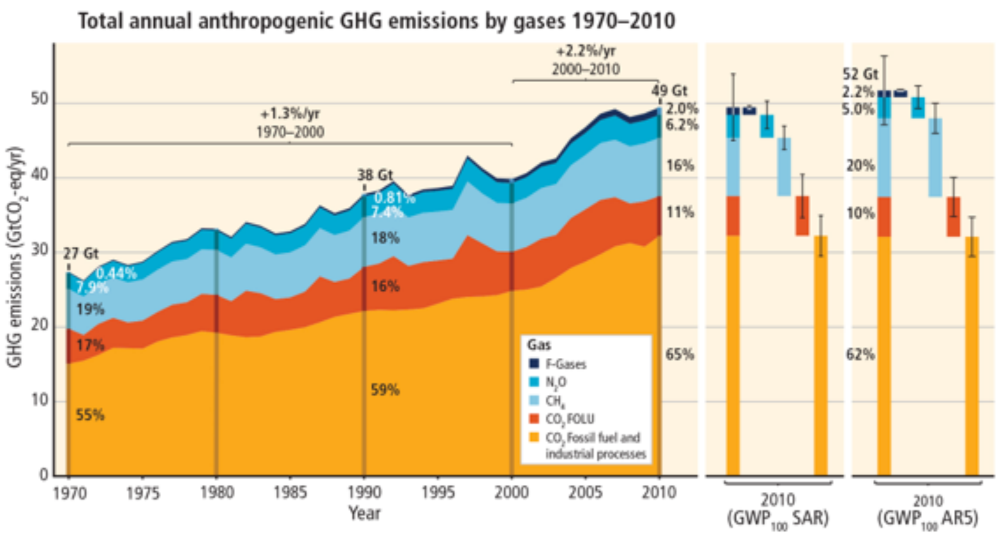


Figure 1.6 Total annual anthropogenic GHG emissions by gases. Source IPCC



1.2 Smart City Drivers

After having analysed several aspects of SC, into this paragraph the research aims to focus on some of the major drivers recognisable below the SC growing. These are, in particular, climate change, resilience, urbanisation linked with population trends and technology. The aim of this section is not to deeply describe each of this macro trends but to give an insight of them as drivers of precursors of the SC phenomenon.

1.2.1 Climate change and resilience

Climate change is a major issue that contemporary cities need to face. The impact of mankind into the environment is relevant and proved by several studies (Crutzen, 2006; IPCC, 2013; Steffen et al., 2007; EEA; 2017). Into this paragraph a general and brief overview of the mankind impact on environment is given, in order to understand main issues for urban planning to be addressed. These can be summed up as following:

- global warming leading to important effects on urban contexts;
- emissions of pollutant, leading to effects on citizens health, on cultural heritage and on climate;
- lack of resilience: the inability of complex systems to react quickly both during exceptional events and slower climate, social, environmental, economic changes (defined stresses and shocks).

Although other relevant effects and issues under climate change can be evidenced, the present research decided to focus only on these three major ones, as directly affecting cities and planning strategies.

Under the definition of global warming the research briefly investigates the general trends of temperature increase at the global level. Several studies, in fact, underline a fast raise in the annual temperature of Earth, which lead to several problems into people life: not only ecosystem challenges (ice melting, disappearing rainforests, etc.) making the general Earth ecosystem in danger for human life, but also challenges linked with urban life, such as Heat Waves, changes in rainfalls, outdoor un-comfort, need for implementing buildings systems for cooling and heating (which can lead to fuel poverty issues), draughts, water shortage, etc. (IPCC, 2013; University of Oxford, 2016; EEA, 2017).

Studies on global warming define three main reasons for the general increase of surface temperature on Earth: volcanic eruptions, solar variability and anthropogenic activities. The first two factors are natural and they have been present from the ancient history of the planet. Their role into global warming is documented and it concurs with anthropogenic activities to the total surface temperature. Nevertheless, comparing current measures of surface temperature with the normal planet temperature era variations, it is possible to affirm that the fast growing of temperature from XIX century is mainly due to human and, in particular, to the emissions of pollutants coming from anthropogenic activities. Different scientists agreed with the assertion that last three decades have been warmer on Earth's surface than ever, since 1850 (IPCC, 2013). The period from 1983 to 2012 was the warmest 30-year period of the last 1400 years in the Northern Hemisphere. The globally averaged combined land and ocean surface temperature data has been calculated as equivalent of 0.85 [0.65 to 1.06] °C over the period 1880 to 2012. In combination with the warming temperature, emissions of greenhouse gases (GHG)[1] are rising, including not only CO_2 but also methane, nitrous, oxide and ozone.

The carbon dioxide, in particular, is considered as the main anthropogenic product coming from combustion of carbon-based fuels, principally coal, oil, natural gas and deforestation.

Figure 1.6 gives the evidence of the increase in GHG production along years. In particular it is evident a peak near the end of XX century, but the increase is registered as constant from the end of 1970's. The more produced gas can be recognised in CO_2, coming from fossil fuel use and industrial processes, which is the main problematic gas for the environment and mankind ecosystem. To sum up, scientists mainly agree considering human activities and, in particular, the spread use of fossil fuel, the main responsible for temperature raise and air quality degradation, with a fast growing curve from the pre-industrial era. In fact, anthropogenic GHG emissions have increased since the pre-industrial era, caused by economy, population growth and fossil fuel-based lifestyle. This has led to atmospheric concentrations of carbon dioxide, methane and nitrous oxide that are unprecedented in the mankind history. Figure 1.5 shows this evidence, putting in relation the observed warming with the main forces acting on the environment. The diffusion of cars and the mass production is seen, generally, as one of the main causes of this peaks in constant growing. In September 2016, observations on Mauna Loa Observatory -the world's marquee site for monitoring

1 see Glossary-Greenhouse gas, p. 20.

carbon dioxide- recorded the meeting of the maximum peak for ppm levels on the atmosphere (400 ppm), which is the non-return level point defined by scientists. Ralph Keeling (the director of the Scripps Institute of Oceanography) (Scripps Institute of Oceanography, 2016)[2] explained how humans have altered the plants process of absorbing carbon dioxide in the atmosphere in a definitive way, by adding more carbon dioxide to the atmosphere than plants can take up, during the year.

As described in (EEA, 2017) climate change has several impacts on societies and people life. Even if, a deep analysis on specific built environment and urban impacts has not been performed, the report evidences several impact trends:

- worsening of climate-related extreme events, both in frequency and intensity and with them worsening of their economic impact[3];
- increasing healthcare problems. In particular heat waves are responsibleseveral premature deaths in Europe.
- increasing heavy precipitations and extreme coastal water levels;
- increasing heat waves and extreme cold (both in intensity and lenght), causing also several deaths;
- increasing deseases;
- changing energy demand and, in particular, increasing cooling energy.

Last EEA report (EEA, 2017) shows in addition the role of forecasting in climate change projections, in order to understand which can be the possible future of clima and, in consequence, of people. The new scientific method named RCPs (Representative Concentration Pathaways) put in relation climate change with policies, forecasting five different scenarios, named SSPs (shared socio-economic pathaways) (EEA, 2017; O'Neill et al., 2015):

- SPP1: "Sustainability - Taking the Green Road". This scenario expects the implementation of actions for mitigation and adaptation, *"low population growth associated with educational and health improvements, reductions in*

2 See the blog post inside the web page of the Institute, available at the following link: https://scripps.ucsd.edu/programs/keelingcurve/2016/09/23/note-on-reaching-the-annual-low-point/

3 Note that the report (EEA,2017, p. 195) says: "[...] in Europe [...] the average annual (inflation-corrected) losses from climate extremes have increased from EUR 7.6 billion in the 1980s to EUR 13 billion in the 1990s and EUR 13.7 billion in the 2000s [...]", and that "the most costly climate extremes were the 2002 flood in central Europe (EUR 20 billion), followed by the 2003 drought and heat wave (EUR 16 billion) and the 1999 winter storm 'Lothar' (EUR 14 billion)". In Italy, losses for climate-related extreme events are existamed in 59,624 euro millions, in respect with 1,945 euro millions insured (3%).

global inequality, increasingly effective international cooperation, and increasing environmental awareness that leads to improved resource efficiency, a boost in green technologies and low energy demand".

• SPP2: "Middle of the Road", which assums that future will not differs in social, economic and tehcnological implementation in respect with history. This scenario leads to "*moderate population growth, slow progress towards achieving sustainability goals and the persistence of fossil fuel dependency, as well as income inequalities*".

• SPP3: "Regional Rivalry – A Rocky Road". This scenario assumes the increase of nationalism, conflicts and low international cooperation, authoritarian politics, leading to "*strong population growth in developing countries and low economic development with islands of moderate growth, but also widespread poverty, limited environmental concerns, and growing resource intensity and fossil fuel use*".

• SPP4: "Inequality – A Road Divided" assuming unequeal development in different regions and countries, increasing the division between country with high level of education and wealth and the other.

• SPP5: "Fossil-fuelled Development – Taking the Highway" based on exploitation of fossil fuels and resource uses.

This analysis is important for having a picture of future possible pathway, in relation with climate change and socio-economic development. Figure 1.7 puts in evidence the position of the five scenarios in respect with mitigation and adaptation policy challenges.

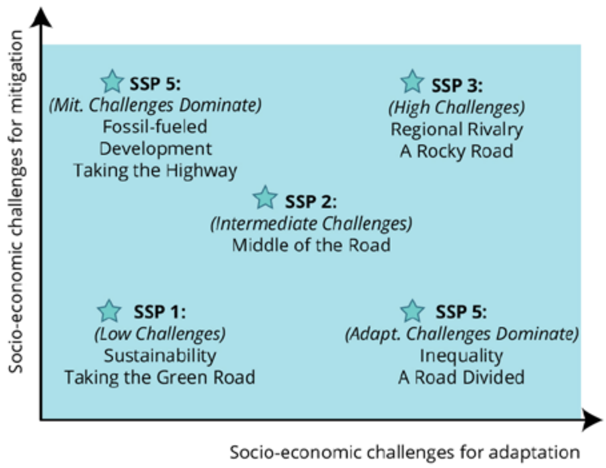
Table 1. 3 Summary of some urban challenges linked with climate change

Main issue	**Urban challenges to be addressed**
Global warming	- Urban Heat Islands - Heat waves - Change in seasonal rainfalls - Drought and flooding - Ecosystem survival
Pollutant emission	- Decrease of air quality - Water and natural resources quality - Ecosystem survival
Lack of resilience	- Flooding due to lack of soil permeability and absence of vegetation - Decrease of air quality due to lack of green - Outdoor un-comfort due to heat waves and heat islands - Water shortage due to the decrease in precipitation - etc.

The third element to be considered is resilience . With this word the research aims to address the ability of cities to react quickly and adapt to occurring events, which can be due to slow climate change, but also to unexpected events. Into this research we mainly address climate resilience, in other term the ability of a city to react to events such as heat islands, heat waves, drought, flooding, water and resource shortage, energy picks of demand, etc. (City of Copenhagen (eds), 2014a; Pickett et al., 2013; Brown, 2015; Davoudi, 2012).

As a resume and a conclusion, each of the highlighted issues leads to urban challenges that need to be evaluated and considered into the planning phase of SC strategies. Table 1.3 gives a resume of that.

Figure 1.7 The Five SPPs Scenarios. Source: EEA, 2017; O'Neill et al., 2015



1.2.2 Urbanisation, population trends and land use

The second driving force considered by this research is population trends. It is well known from several important studies (Engelman, 2009; UNFPA, 2014b) that population changes and migrations can affect urban systems in several ways. The major trends under this topic can be briefly highlighted and described as following:

i) **Urbanization**. Scenarios on population urbanization highlight how the world is undergoing one of the largest wave of urban growth in history, with more than half of the world's population living in cities. The prospect of UNFPA (UNFPA, 2014b) expectes an addition of 1.5 billion urbanites in the next 15 years and of 3 billion by 2050 (Fig. 1.8). The increasing of worldwide urbanization can lead to inequalities and people vulnerabilities, especially in parts of the world where informal agglomerations (slums) are growing day-by-day (Fig. 1.9). Not

Figure 1.8 The world's urban and rural population, 1950-2050 (UNFPA, 2014b)

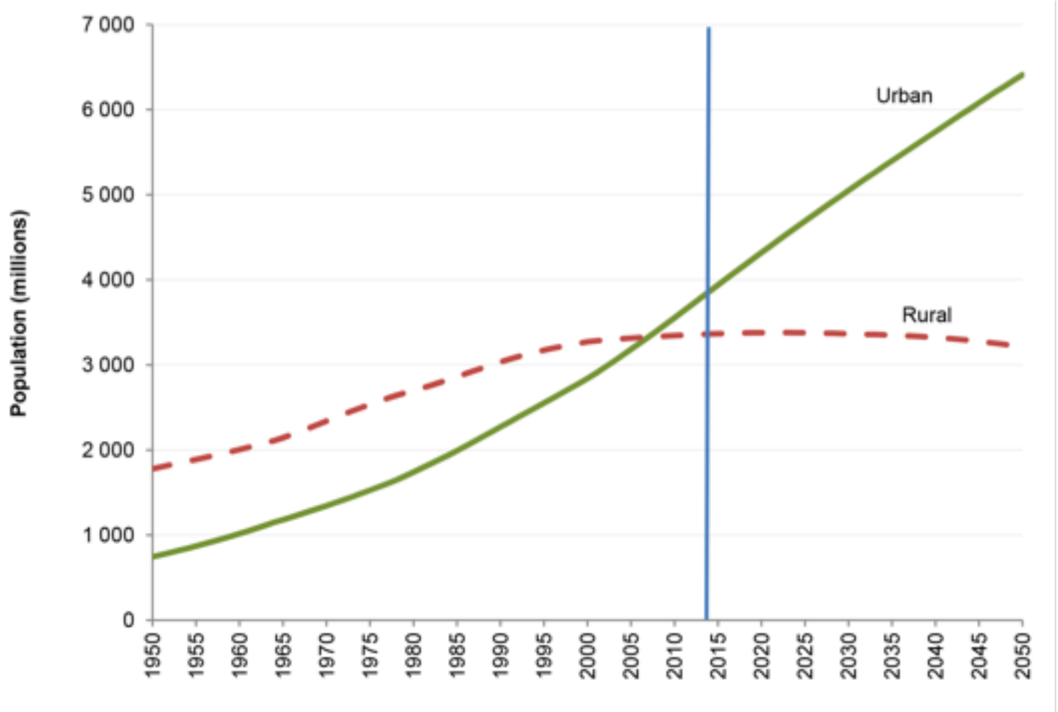
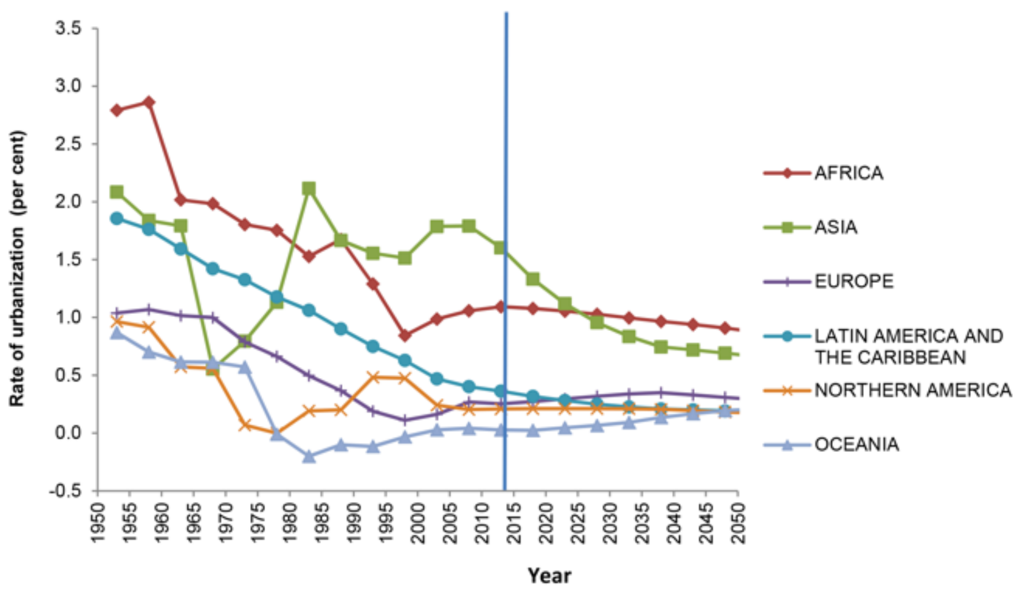


Figure 1.9 Rate of urbanization by major area, 1950-2050 (UNFPA, 2014b)



only: the intense urbanisation can lead to exclusions (or discrimination) problems also in the richer countries, with lack of affordable houses, resources and access to energy facilities. Then, challenges regarding urban sprawl and ceiling coverage, as well as regarding resilience of the urban system itself, are also linked with the intense urbanisation. This phenomenon is more intense in Asia and Africa, where not only high income population is moving toward cities, but also low income ones (UNFPA, 2014) (Fig. 1.10).

ii) **Migrations** due to climate change and to economic or political reasons. In 2015, 244 million people, the 3.3% of the world's population, lived outside their country of origin. The migration phenomenon can be due to several reasons: wars, economic constraints, but also climate change which leads people to flee from extreme weather events and lack of resources (UNFPA, 2013).

iii) **Ageing of population**. People aged 60 and older make up 12.3% of the global population, and by 2050, that number is expected to rise to almost 22%. This is the result of healthcare and sanity that make possible longer lifetime. Indeed, with the decrease of fertility rate, elders are growing in respect to youth (now the 28% worldwide). The ageing of population need to be taken in consideration in order to address both the vulnerabilities of this part of society and potentialities of integration (UNFPA and HelpAge, 2012).

These highlighted elements are just some of the important issues affecting urban areas and services inside cities. In particular, inequalities, inclusion, fuel poverty and lack of affordable houses need to be addressed in collaboration with mitigation and adaptation policies. For a deeper insight on population trends and issues, the UNFPA website (http://www.unfpa.org/) is the main referee, in

Figure 1.10 Percentage urban by income group, 1950-2050 (UNFPA, 2014b)

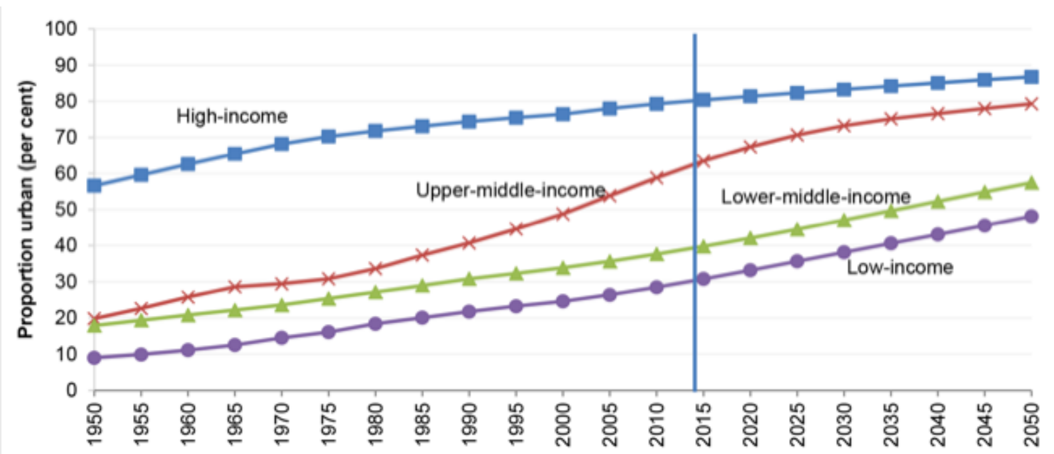


Figure 1.11 Schematization of different networks acting inside urban systems

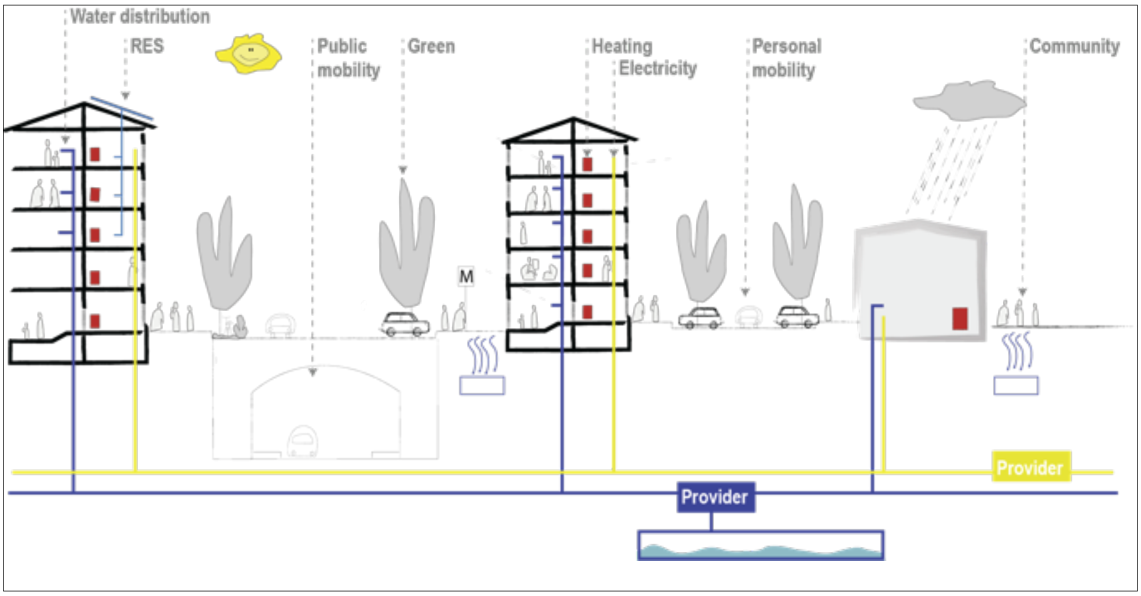
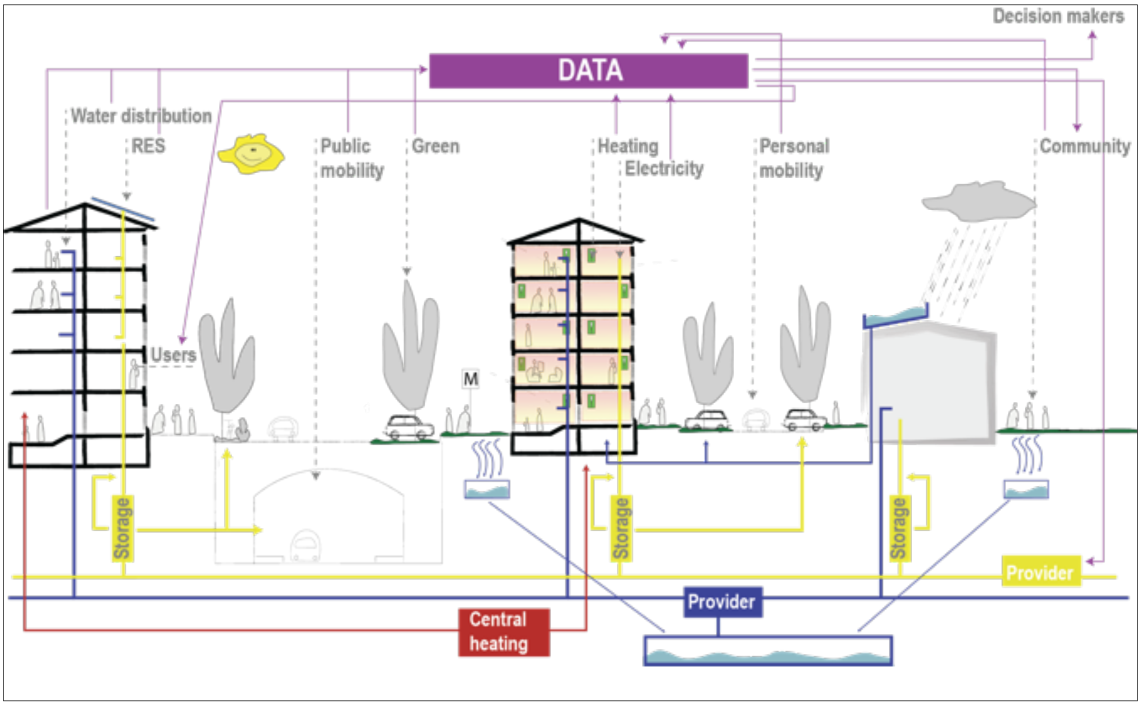


Figure 1.12 Schematization of synergies between innovative approaches and urban system



particular the following reports (UNFPA and HelpAge, 2012; UNFPA, 2008, 2014a, 2014b). Nevertheless, these modification of social composition, migrations, climate change and general economic crisis exacerbate important challenges, such as, for example, fuel poverty. This issue happens when people could not afford the cost of energy: as a consequence a growing percentage of population, inside advanced countries, live in high un-comfort conditions inside their houses (Boardman, 2013; Liddell, Morris, 2010; Lewis et al., 2013).

1.2.3 Cities technological infrastructure

Technology is nowadays a preminent component inside people life, composing a wide material and immaterial infrastructure inside cities. However, not only digital technologies are present, as the term infrastructure refers to a wider range of component and elements. In fact, infrastructure is, with buildings, a necessary component of cities, in order to answer to liveability needs. As defined by several authors, their design has been present sinche the Roman Empire and it answered to a holistic view of the city, to a precise image (Gilles, 1985; Losasso, 2016). As highlighted by Bertrand Gilles inside Technical History (and re-cited by Losasso in Techne vol 11, 2016), technical systems have always been associated with economical and social dimension, giving a precise answer to current constraints. Today, the economic growth gives an implified dimension of infrastructures, which is, sometimes, less manageable and under control maybe due to the absence of precise drawings and urban visions (Losasso, 2016). In addition, the redefinition of infrastructure's role is leading to its interdependency and to a new immaterial dimension, mantaining, in the same time, a predominant role in making cities usable and functionable (Losasso, 2016). Nevertheless, this important driving force of change is not a unicum into the history of humanity. In fact, it is possible to observe important similarities inside history: for example, those caused by the Industrial Revolution, by the electricity invention, by the use of concrete into the constructions sector, by the engine and cars' age. Therefore, often, such innovations were triggered by states of crisis, resource shortages or environment/hygienic problems (Hajer & Dassen, 2014). As in the past, at present, the diffusion of innovative technologies inside all levels of people life is seen as a similar revolution as it has influenced in a relevant way urban contexts both on physical and social space (Cairncross, 1997; Claudel & Ratti, 2016; Hajer & Dassen, 2014; Mitchell, 2000; Smith, 2001). When speaking about SC, generally, the technology intended is the Internet-based technology and the ICT sector.

In fact, it is reasonable to affirm that the inclusion of such technologies inside people life is growing day by day and it is putting the discussion about integration of systems at the centre of an important part of the debate (Claudel & Ratti, 2016; Mele, 2016; Smith, 2001). But speaking about innovative technologies, applied to cities, doesn't only mean considering ICT, but a wider range of other devices and instruments. In fact, cities are shaped with a very complex and interrelated technological architecture (Losasso, 2016), defined by several networks, such as energy, water, waste, mobility, ICT: as the hydropolis, electropolis, informational and cyber city described by (Graham, 2000). As evidenced by Graham, all those cities are strictly interconnected and very rarely one infrastructure is developed alone or modifications inside one part don't influence the other.

Innovative technologies enter inside this network which is multi-layered and complex, with the aim of optimisation, efficiency and increased sustainability and it is reasonable to evidence how new technologies aim to enhance the dynamic configuration of these systems, following several trends, as evidenced by (Claudel & Ratti, 2016). Some of these trends can be highlighted as following:

i) Participation 2.0: involvement of citizens inside decision-making. Different enablers are available: not only cities' platform, which can be well conceived and can become real services (as in the case of Amsterdam), but also apps allowing citizens to participate into the real life of their neighbourhood (e.g. apps allowing to report on space problems, etc.).

ii) Data collection. The trend about collecting data is maybe one of the most pursued one, actually. Data are considered of high value for addressing any sort of strategies on urban systems. They can cover different themes: building behaviour, indoor and outdoor performances, people behaviour, energy management, mobility, etc. Innovative examples of data collection are systems based on crowd-monitoring, where smartphones are playing a central role into revealing the position of people inside a space.

iii) Automation and responsive objects. A big part of technology developers are addressed in producing various objects able to directly act in dependence of a specific input. The Passenger city can be a specific example. (Claudel & Ratti, 2016) calls Passenger City the trend seeing cars become self-driving: instead of being parked 23 hours per day, each car can self-drive with optimised trajectories for example for different component of a family. Also Climate control systems whit intelligent thermostats are examples of the same trend. Instead of having homes heated or cooled when people are not inside, intelligent thermostats can switch on and off the system only when necessary.

iv) Redefinition of common and public spaces uses. The trend of re-define education systems and works is going toward the delocalization of activities inside homes, leaving public space for other uses.

v) Increasing of personal/small economies, makers, personalisation of objects, services and innovative cultural and artistic production is gaining a new age through the use of the digital world. Mass production is giving the way to original and personalized products.

All these evidenced trends seems to have a backbone in solving specific challenges (Santamouris, 2016), which can be described as following:

i) to increase the global energy efficiency and sustainability of the urban system;

ii) to increase the global resilience of the urban system;

iii) to enable consumers through digital;

iv) to optimise the management of the system, e.g. by detecting losses (water, electricity), by connecting networks, by making more effective transports, etc.

If cities' infrastructure is schematized as in fig.1.11, it is possible to visualize how innovative technologies interact with the actual urban system (fig.1.12). Please note that both picture are schematization of the concept.

The circular system coming out from optimization and collection of data is one of the main objective of such strategies and technologies application (M. Batty, 2013; Michael Batty, 2008).

Therefore actual technologies can also be described evidencing their role as passive or active enablers. In fact, current devices and strategies can be divided into active enablers, when technology is physically added, as an object (sensors, systems, etc.) or in passive enablers, when the technology is not a physical object but a strategy able to activate passive benefits (e.g. more green surfaces produce more evapotranspiration which produce benefits to the resilience of the system).

Table 1.4 resumes some of the main trends of innovative technologies found in major cases study. The table is the result of the case study analysis conducted in the present research, which extends the studies conducted by (Neirotti, De Marco, Cagliano, Mangano, & Scorrano, 2014).

As a conclusion, technology is currently considered as a major part of SC development, both when speaking about digital / ICTs technologies and building or passive technologies. It seems clear that planning a SC need a complex and multi-layer approach in order to meet some of the challenges that future cities are facing. As defined by (Graham, 2000), technological components are part of the urban system and contribute to the collaboration among different systems and innovative devices need to be framed in order to enhance these interrelations but also to enable citizens and consumers to be part of the economic circle.

Table 1. 4 Summary of some most used technologies (ICT or not) divided in themes, as proposed in (Neirotti, De Marco, Cagliano, Mangano, & Scorrano, 2014). The original list have been completed with personal observations

	Theme	**General description**
Energy	Smart Grid	Electric network able to take in consideration the energetic request of all connected users, on a real time perspective. It is also able to manage peaks of demand.
	Lighting	Lighting systems able to have different functions at the same time: lighting (often LED), air quality control and monitoring, Wi-Fi hotspots, traffic management systems. Real time systems. Multi sensorial integration: architectural, sound and lighting.
	Green and renewables	Renewable systems able also to monitor consumption and give real time information.
Mobility	Transport	Meaning of transport (e-bike, e-vehicles). Intermodal systems.
	Logistic	Innovative transport network and systems. Management instruments of loads and roads.
	Info - mobility	Users information and monitoring
Resources	Water	Water management systems on the ICT level, physical transformation level (e.g. streets quotes), water collection basins, vegetation implementation.
	Air	Air monitoring and management with ICT systems, but also with vegetation implementation targeted to CO2 emissions reduction.
	Waste	Urban waste management through monitoring and real time data collection, recycling systems, re-use of organic waste for green energy production or for urban agriculture.
	Urban Agriculture	Urban gardens and agriculture, greening and vegetation able to effect mitigation and to produce food. Sensors implementation.
Economy	Sharing Economy	Instruments and services for the development of shared economies (ICT systems for food transport and sharing). Sharing experiences.
	Cultural economy	Augmented reality, digital technologies and apps for an enhanced culture use.
Society	Safety	Citizen's protection through citizens active involvement, also with the presence of ICT systems and alert systems. Open space design as a prevention system (lighting and flux management, usages on time, etc.).
	Participation	Citizens' involvement through participative processes, through education methodologies (interactive and analogic). Information share.

Table 1. 5 Deepening on ICT sector: a brief analysis

Deepening on ICT sector: a brief analysis
Digital technologies and ICTs are the currently most used technologies for making cities smarter (M. Batty, 2013; Michael Batty, 2008; Kitchin, 2014; Vallianatos, 2015). But inside this sector lot of application and devices can be evidenced. In this box are evidenced some of this application. This box provide a brief inside on some ICT tecnologies.
Different trends acting into the contemporary city and mainly related to the evolution of digital infrastructures and to the sustainable evolution, can be identified: web-based technologies; data gathering and computing; software-based tools for planning; digital-based objects / products. In fact, some of the most common devices applied in cities can be summarized as following: - models and interoperable systems or platforms (e.g. data platforms in which it is possible to find information on climate, on services, etc., but also the systems and models based on a software that make easier the urban management and planning); - sensors and capturing systems, storage platforms (e.g. sensors for pollutant emissions and energy consumption); - networks or displays allowing the sharing of information and data (e.g. e-government platforms); - automation systems (e.g. systems allowing the use of automatic functions3); - different kinds of apps and end-users services (e.g. apps for parking or pay as your throw systems for waste management, etc.); - physical infrastructure allowing the digital soft-structure function (optic fiber, wifi repeaters, etc.). Nevertheless, digital technologies are made possible by some improvement and innovations (AA.VV., 2013; ISO/IEC JTC 1, 2014) inside the sector in itself: - ubiquitous computing, a specific software engineering in contrast with desktop computing, allowing the presence of computing everywhere. This allows an interaction with digital services through different forms and objects. - networking technologies which make devices, computers and people able to interact through communication paths. - open data, that means making available sets of data (generally administrative, research, or governmental) to the public for visualisation, use and re-use. - big data, which are defined as “any collection of data sets so large, complex and rapidly changing that it becomes difficult to process using traditional database management tools or traditional data processing applications” (ISO/IEC JTC 1, 2014, p. 17). - GIS (Geographic Information System), that is the possibility to provide location based services. - Cloud computing, that is the use of internet based products (computing) as services instead of as products. As an example, the archiving services on internet: the archive is used as a utility to users, that are not configured for one specific user but are available (and used) in a rapid and fluid way to a group of users. - SOA (Service-Oriented Architecture), which is a software architecture (or frame) able to support the use of Web services in order to guarantee the interoperability among different systems. This allows the use of single applications as components of a overriding system. - E-government, it is the possibility for administrations and governments to interact with citizens and other stakeholder on a digital based platform. - Embedded networks into the urban context; they are systems and services integrate into the space. For instance sensors and devices giving a real-time computing capacities and end-users displays. - IoT (Internet of Things), that is literally the possibility to all objects of being connecting through Internet. It is expected that this system will allow important evolutions into the life-style of into the urban management. As a simple example, an alarm clock can ring before or later in correlation to traffic congestions data.
Gaps to be fulfilled
Those technologies aim to fulfill the technological needs for smart urban development. As set by the ISO and IEC associations, the smart city has several technological needs, summarized as following: - to develop coherent models for system interoperability; - to share the use and compatibility of different systems; - to make data exchange fluid and rapid; - to facilitate the use of aggregated data and improve the querying; - to ensure that the data are used in a safe and secure way (also sensible data); - to allow a greater automation.
Economic potentialities
The technological sector on ICT is reaching important market development’s targets, even if the International Energy Agency declares that 65% of the economic potential of energy efficient technologies are still untapped (Santamouris, 2016; Van der Hoeven, 2011). Actually, it is expected an increase to 1365 billion of euros by 2050 of energy efficient products total volume (in 2013 the amount was 825 billions) (BMUB, 2014; Santamouris, 2016).

1.3 Smart City instruments: strategies toward 2050 and policies outline

Into this paragraph the research aims to briefly highlight main policies and legislations as instruments for SC development.

The Europe considers SC as an important way to achieve climate and development goals (Directorate-General for internal policies- European Parliament, 2014). Into this paragraph we briefly describe the main European policies and roadmap for 2050.

- The first important document is the **Europe 2020 strategy**. The strategy set three main targets that are nowadays under development through the use of Horizon 2020 funds. These targets were implemented by the Commission since 2010 and were the following: 1) to reduce the greenhouse gas emissions by 20% compared to 1990 levels;2) to increase energy efficiency by 20%; 3) to increase the contribution of renewable energies by 20%.
- The **European Roadmap for 2050**. The roadmap increases the requests to European countries until the 80% of reduction of the carbon emissions, still compared to 1990 levels. This roadmap, in addition, define some intermediate milestones and, in particular, the reduction of 40% by 2030, and of 60% by 2040. These two are the main roadmap documents set by the European Commission.
- **Directive Energy Performance of Buildings** (EPBD) developed as an European Concerted Action, it requires that all new buildings follow the standards of NZEB (Nearly Zero Energy Consumption). There is a distinction from general buildings that need to achieve this objective before 2020 and public buildings by

Table 1. 6 Summary key documents ad the European level

Summary key documents	Year
SET Plan	2007
Renewable Energy Directive	2009
SET Plan	2009
Energy Labelling Directive	2010
Directive Energy Performance of Buildings (EPBD)	2010
A Roadmap for moving to a competitive low carbon economy in 2050	8/03/2011
Europe 2020 strategy for smart, sustainable and inclusive growth	2011
Energy Efficiency Directive	2012
ISO 37101:2016 Sustainable development in communities	2016

the end of 2018.

• **Energy Efficiency Directive** developed by the Commission. This directive requires Member States to refurbish 3% of governmental buildings per year and to define mandatory schemes for energy efficiency with the aim of achieving a rate of 1.5% of energy saving per year.

• **Renewable Energy Directive**, which asks each sector to provide specific targets regarding the share of renewable energies.

• **Energy Labelling Directive**, which defines the requirements for energy technologies used in buildings.

• **ISO 37101:2016 Sustainable development in communities**, which develops a stardard for sustainable, smart and resilience management in communities. In particular, the standard aims at defining a management system for sustainable development in communities, following the objectives of: 1) managing sustainability and fostering smartness and resilience in communities; 2) improving the contribution of communities to sustainable development outcomes as well as to smartness and resilience; 3) assessing the performance of communities in progressing.

Then there are several initiatives, developed and launched for the implementation and fostering of SC initiatives:

• (2007 and 2009) SET Plan in which the SC is assumed as a key initiative for meeting the energy efficiency objectives. The Plan scheduled the launch of a European Industrial Initiative on Smart Cities with the aim to create the conditions for technologies diffusion and implementation.

• Member States' initiative for smart cities launched in 2011, it counts 21 signatories EU countries. It has several aims: among them the coordination of actions, the support of stakeholders, the condivision of best practises.

• European Alliance for Energy Research (EERA). This alliance is formed by 15 European Research Institutes in collaboration with the European Commission. The major aims are to optimize, expand and strengthen the European research capacity through the share of knowledge and materials. One of the joint programs developed by EERA, is the Joint Programme Smart Cities and it is specifically aimed to develop methods and scientific instruments for the SC development.

• European Innovation Partnership on Smart Cities and Communities (EIP SCC), approved by the Commission in 2012, it shares resources for the implementation of demonstration project on SC. The partnership is implemented through two separate governance structures: the Stakeholder Platform and the

Table 1. 7Main policies at the Italian level

Policy name	Main findings	Year
D. 2010/31/UE	Implementation of EU directive on NZEB and low-emissions buildings. Within 2020 new buildings will be NZEB; from 2018 public buildings will be NZEB; creation of themandatory energy performance certificate; definition of energetic performance for all buildings.	2010
DL 9/02/2012 n°5 and L. 4/04/2012 n°35 (art.47)	Implementation of the Italian legislation Europe Digital Agenda directives. Inside art. 47, it is defined the modernisation of relationships between local government, citizens and industry also with the use of digital services and broadband connection predisposition.	2012
DL 22/06/2012 n°83 and L.7/08/2012 n°134 (art.20)	Creation of the Italian Digital Agenda aimed at follow directives of European Digital Agenda and to define italian challenges and needs on digitalization of society.	2012
DL 18/10/2012 (art. 19, 20)	Definition of Smart Communities and creation of a related Task Force. Italian Digital Agenda can define strategical interventions aiming at creating Smart Communities, digital valorization of the cultural heritage, digitalization of society, sustainability on the territory, as well as implementation of mobility, industrial and research services.	2012
DL 179 del 18/10/2012 (Decreto Crescita 2.0)	Definition of key elements for fostering the national growth. Among them the innovation is considered one of the major potentialities: innovative start-ups, digitalization of society and implementation of citizens' digital services.	2012
D 2012/27/UE	Implementation of the 2010/31/EU directive by defining some instruments for achieving buildings energy performances targets.	2012
DL 2013/63	Further implementation of 2010/31/EU directives and definition in detail of building energetic performances.	2013
STREPIN and PANZEB	Creation of two framework documents as guidelines for the renovation of the italian built environment. The STREPIN is the Implementation Strategy for the renovation of national built environment; while PANZEB is the National Action Plan for the implementation of NZEB buildings.	2015
L 2015/221 (Collegato ambientale)	Definition of strategies for valorisation and preservation of the environment.	2015
DDL 1/02/2016 (under legislation iter)	Definition of accelerating instruments for enabling Smart Cities. In particular, definition of Experimental Campus of Innovation and of a National Unit for SC national developed. Wrote with Cultura Democratica (see Annex III.2, p. 383).	2016

High Level Group.

Another important technology roadmap is the European Initiative on Smart Cities, developed under the SET plan process. It is aimed to support cities and regions in developing measures by 2020 for reduce the 40% of greenhouse gas emissions through sustainable use and production of energy. Finally, of great importance is the last agreement result of the COP 21 - the Conference on Climate Change held in Paris in 2016. Here, nations participating on Kyoto protocol and on UNFPCCC (United Nations Framework Convention on Climate Change) decided to mantain under +2°C the increase of surface temperature in respect to pre-industrial level.

In Italy the legislation framework on SC starts mainly in 2012 with the Italian Digital Agenda. In general the Italian legislation follows the European Directives and international agreement with the introduction of action plans and measures of the territory. In 2016, in addition, Italy created a task force on Smart City development with the MISE (Ministry of Economic Development) aiming to define a framework for allocating 65 millions of euros. These funds are aimed at foster the diffusion of Smart Strategies inside the territory. The main task force responsibility is to define pilot districts, a general framework both on strategic and economic poin of view. Then, in 2016, Italy also ratified the Paris COP 21 Agreement.

Italy also adheres to the Smart Specilization Strategy. In Emilia-Romagna, for example, the S3 is of particular interest as they put innovation and urban regeneration at the centre of the strategy. Strategic priorities for the Emilia Romagana region are the following:

- food sector;
- construction and buildings;
- mechatronics and motoring;
- culture and creative industries;
- healthcare industry.

Under the construction and buildings priority, a specific attention is given to sustainable buildings, to smart cities and urban regeneration.

2 Approaches from Smart to Green Cities . A case studies interpretation

The SC concept is applied worldwide in different ways: sometimes it is conceived as a punctual project on a city, occasionally is more conceived as a network project (e.g. thermal, electrical, mobility), other times is outlined as an holistic and complex design strategy regarding the entire city. As well, there are few different typologies of smart projects, depending on the specific object implemented (a technology, a process, a strategy, an approach) and on the target (sustainability, people participation, social or economic challenges). The approaches for implementing SCs are several and different. All of them have specificities. Depending on the application, on the typology of projects, on the urban sectors of application, on the general aim, it is finally possible to find several SCs.

The aim of this chapter is to analyse the different expressions of SC application and to understand the role of the application of holistic strategies into pilots. In fact, often SCs application are outlined in portions of the city having some social, economic and urban specificity: the district[1].

The chapter is structured in three parts: the first one analyses SCs into the European context aiming at analysing the diffusion of the approach, the second part clarifies the interpretation of this research on real SC applications and gives an extension of SC definition toward Green Cities. The third part proposes a brief analysis of some case studies as evidence of the interpretation. The selection of case studies was made on the base of best practises in Europe (see paragraph 2.3, p. 117).

The sources used to achieve the aim are: i) conference paper, books, journal articles referring to the definition of smart strategies applied to the urban dimension; ii) websites of municipalities and cities having implemented SC projects iii) Cordis database and EU funded projects websites.

The main questions to which this section of the research aim to answer are the following:

- how smart strategies are applied to cities?
- what are the macro-trend?
- is it possible to define some success factors?

2.1 European context: medium-sized and big cities

The SC has reached an important fortune and lot of cities around the world are starting to implement different kind of smart strategies applied to the built environment. The research aims to focus on the application of smart strategies and approaches on the existing built environment (generally named brownfield), instead of on new establishment (defined as greenfield[2]). The extension of the SC phenomenon is very high, not only in metropolitan area but also in medium-sized cities. According to some relevant studies conducted by the European Parliament and by different platforms, into the European context this typology of cities is strongly spread in all EU countries (Directorate-General for internal policies-European Parliament, 2014), meaning that in Europe an increasing number of cities is implementing strategies attributable to SC's ones. As the European

1 see Glossary-District and Neighbourhood, p. 20

2 Example of greenfields are Masdar, the PlanIT Valley and Songdo. See (Caragliu et al., 2011; Shelton, Zook, & Wiig, 2015; Washburn, D., Sindhu, U., Balaouras, S., Dines, R. A., Hayes, N. M., & Nelson, 2010). The research decided to doesn't focus on greenfield as the challenge given by the actual existing built environment are conceived as more urgent.

Parliament highlights, 51% of European cities with at least 100,000 inhabitants meet the criteria for the accreditation into the smart group and are extended into all European countries[3]. In addition, the 43% of identified SC fit into the group of medium-sized cities, between 100,000 and 200,000 inhabitants. Figure 2.1 shows the number of smart identified cities divided into the different population ranges. The graph shows the evidence of the increasing number of medium-size cities implementing smart strategies.

This data is important in order to understand the evolution of the topic, it shows in fact that the phenomenon is not concentrated into a few numbers of big cities, but it is more spread into medium-sized ones. As a difference with other worldwide territories, the historic formation of the European urban texture is indeed marked by small and medium conurbations, having a high density into the land and an important role into the development of the citizenship. For this reason, the implementation into these contexts of innovative strategies or, at least, of a debate on regeneration, reduction of energy consumption (through the use of technology or other instruments) and mitigation actions is necessary and important in order to foster and accelerate the transition of the European territory, conceived as a whole. The increasing role of Majors and local government into the development of urban strategies, compared with the role assumed by national governments and with the repercussions and effects of national and general policies, could be one reasons for this extension of interest in smartness (European Commission Directorate General, 2015)[4]. Nevertheless, observations of Figure 2.1 show also the role of big cities into the development of these kinds of strategies: 46 of 52 cities analysed with more than 500,000 inhabitants (88%)

3 The analysis is conducted by the Directorate General for Internal Policies of the European Parliament. They analysed cities with at least 100.000 inhabitants in EU-28 countries. The selection is conducted through the observation of strategies and projects ongoing into these countries and cities with at least one project into one of the main six smart sectors are selected as smart. Those sectors are better explained and evaluated into the chapter 1.1.3 and are the following: people, governance, environment, mobility, living, economy.

4 The national governments are important in order to address the general strategy for the renovation of urban context and the implementation of innovative strategies, but the fallout that can be achieved by the specific local governments are more precise and effective. The reason is the specificity that each city and territory has into the European context and into the same country in itself. The Italian case is exemplary for this because it is characterized by a plurality of different challenges, needs and specificity, that are hard to handle on a general level.

Figure 2.1 Number of SCs in relation with inhabitants. Source: Directorate General for Internal Policies (2014)

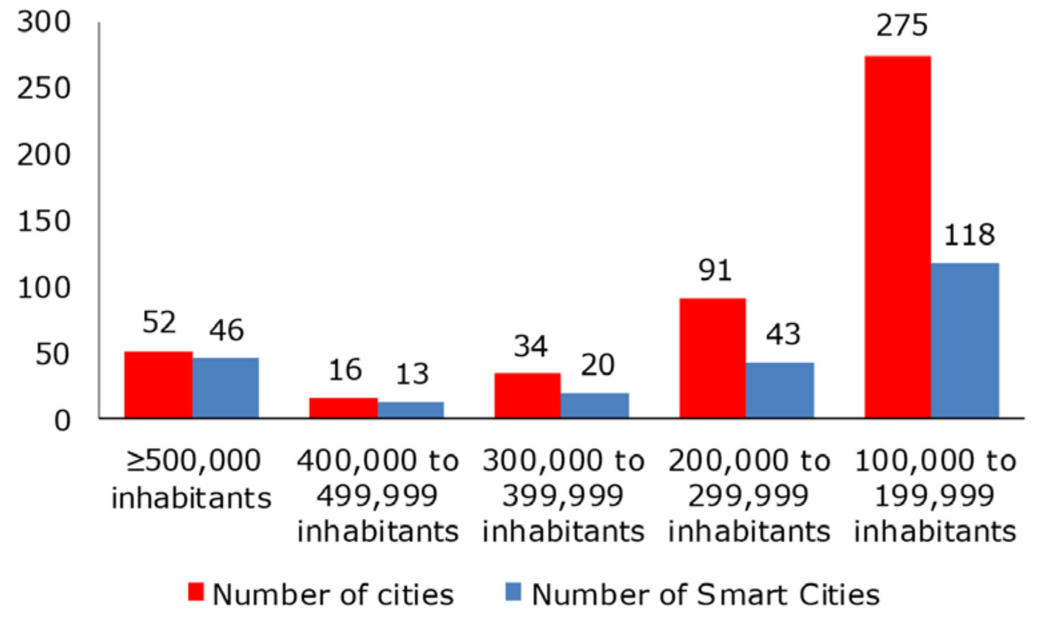
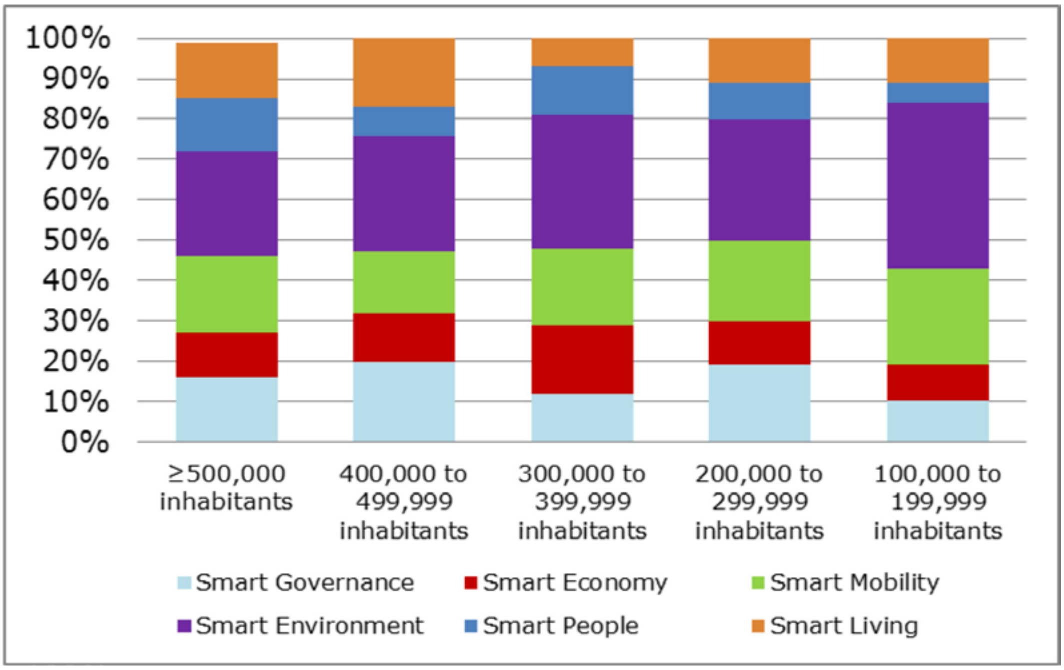


Figure 2.2 Smart Cities in relation with main sectors. Source: Directorate General for Internal Policies



are implementing at least one project into one of the six main smart sectors (Fig. 2.2). Thus, those realities are significant for different reasons: they can address solutions into portions of the urban site acting as pilots and testing sites for the implementation of strategies into other contexts; moreover, they can improve technologies and collect funds from a wider panel of stakeholders and redistribute them or generate circular economies affecting in a positive way other cities around (Espon, 2012).

The increasing importance of medium-sized cities highlights another significant aspect: their rising role into the development of strategies for refurbishment and emissions can go beyond country boundaries, as well as beyond European ones. Besides, the activity of the Covenant of Major, for example, is projected on a worldwide dimension, highlighting the extension of the phenomena and pointing the accent on a debate about the former role of national countries and the new role of majors. As well, other important associations, giving the dimension of this phenomenon, are for example the following: the SC Stakeholder Platform, the 100 Resilient Cities Platform, the SC and Community platform. All these platform and associations gives the physical dimension of the phenomenon of SC, sustainable cities and of the importance in the world for renovating cities, reducing their energetic consumption and greenhouse gas emissions.

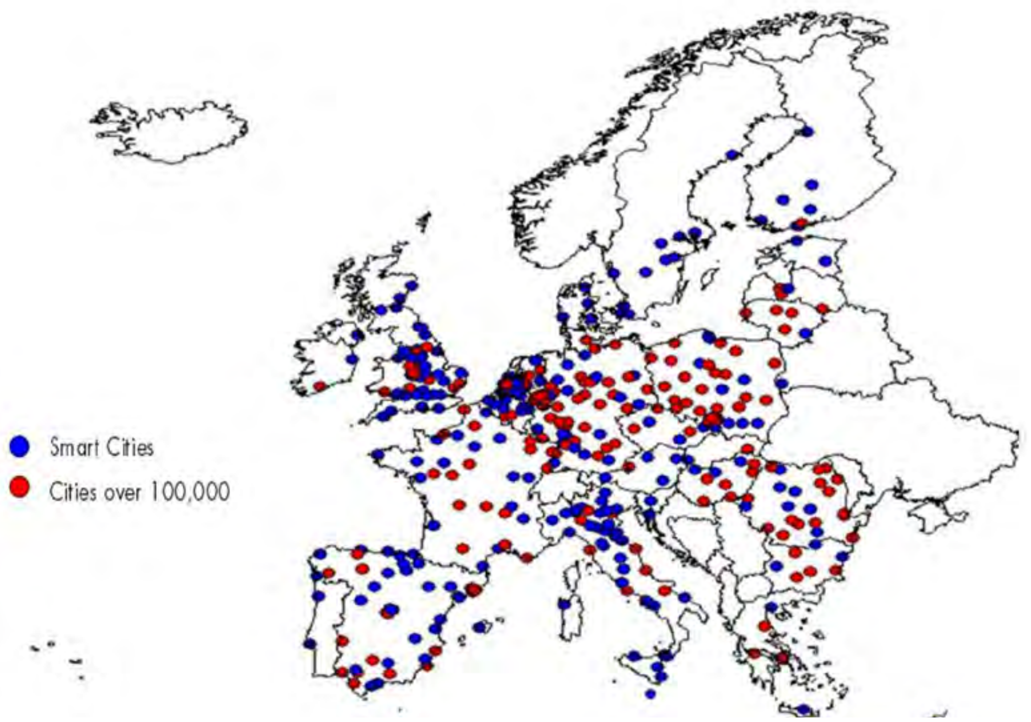
However, there are several differences between projects recorded in the EU context. The first and most important one is the dimension of the project in itself. Not all cities are implementing holistic approaches, meaning with this definition the implementation of projects able to act on the totality of the city context, but lots of them have implemented more sectorial actions (Directorate-General for internal policies- European Parliament, 2014).

It is possible to analyse the general distribution of thematic projects, by using the already mentioned 6 general sectors. Figure 2.2 shows the relationship between SC characteristics and cities' size. As already anticipated, the relation between the smart topic, sustainability and climate change is strict. Their relation can be defined as cause-consequence relation where the SC is one of the possible answers to the necessity for urban sustainability.

Indeed, the smart environment characteristic (or sector) is the prevailing one in each cities' size. After the definition of actual environmental challenges in 1997 with the Kyoto protocol and furthermore, in all next agendas, and with the enactment of the 2010 and 2012 EU directives, it is clear that actions related to the

Figure 2 .3 Percentage of SCs per county. Source: Directorate General for Internal Policies

Figure 2 .4 DiffusionofSCsinrelationwithcities(<100,000inh.). Source:DirectorateGeneralforInternalPolicies



environment are conceived as a priority for national government. If we analyse the presence of SC, following the EU criteria, it appears evident the dimension of the phenomenon and the attention that quite all the European countries are giving to smart and sustainable strategies. For some authors (Singh, 2012) the smart trend could be seen as a new major trend. Its extension is indeed involving an increasing number of cities worldwide. For instance, the Indian government announced in 2014 the development of new 99 SCs. Figure 2.3 highlights the percentage of SCs per country in Europe and Figure 2.4 evidences the diffusion of SCs in relation with cities with less than 100,000 inahbitants. The most concentrated countries are Italy, Sweden, Finland, Netherlands, Estonia, Austria and Slovenia.

In Italy, the SC revolution is growing day by day with a large impact on cities and communities management. After being one of the country in Europe more active into the platform Covenant of Major (3187 joint signatories, compared to the 1438 of Spain, the 83 of France, the 34 of United Kingdom, and the 24 of Netherlands), Italy candidates itself for being one of the main context for the development of SC initiatives. The ANCI Observatory of Italian SC[5] calculates a totality of 1311 specific smart projects, with the involvement of 15.446.552,084 citizens and € 3.713.591.167 of investments. Into the platform 150 municipalities are collected and described with the specification of processes involved, funds structures and citizens engaged.

2.2 Interpretation of key factors from Smart to Green cities

Several approaches can be identified when analysing real SC applications, depending on urban scale, on the way of application and on the dimension of the city. Into this paragraph the research aims to interpret some key factor which is possible to identify when analysing case studies. Paragraph 2.3 gives the evidence of this interpretation by selecting and describing some interesting best practises.

The first factor analysed is the scale of application of SC projects. In fact, it is possible to identify different scales of application, answering four main different approaches: the first one is the application of punctual projects on a context; the second one is the application of projects affecting networks (e.g. mobility, thermal, electric grids); the third one is the application of strategies on the street dimension; the last one is the application of holistic strategies on a selected area

5 For more information see their website: http://www.italiansmartcity.it/about.php

which could be the entire city or a portion of it: a district or a neighbourhood. The peculiarities of each approach can be resumed as following:

- **Punctual applications**. They are developed through the application into a specific context of a singular device (or technology or even method) aiming to address a specific challenge. Example of this is the application of BigBelly bins[6], developed by the BigBelly company for addressing urban waste management. Different cities have applied this innovative technology into their context, with or without the connection to other complementary smart management systems into the city. As the example provided, punctual applications are mainly specific devices or technologies, studied for solving very specific problems on the urban context (other devices can be found for energy management, e-governance application and others). However, punctual smart applications are not only technologies or physical objects, but they can also be constituted by a smart use of a specific space. As an example, the association BAUM (Bolognina Arti Urbane in Movimento[7]) with BaumHaus[8] have proposed in Italy, into the challenging urban context of the Bolognina District[9], an "analogic" blackboard using, as a support, the enclosure of a construction site. The association, with the use of a specific painting, transformed the fence from an anonymous enclosure to an interactive space where the community can draw, write and express their needs and wishes for the district. As a third example of punctual smart application, there are all improvements made on the buildings level: NZEB buildings for new constructions, the retrofitting of single buildings, the application of innovative instruments (sensors, intelligent façades, or other) on one building, the design of smart homes are all examples of punctual applications. The DemoHouse, developed by BeNext, is an example of this, in Amsterdam[10] . In conclusion punctual smart applications are all the devices, technologies, uses of a punctual space, that can be evaluated

6 For more information see: http://bigbelly.com/places/cities/ and box X.X

7 For more information on the association see https://www.facebook.com/BAUM-Bolognina-Arti-Urbane-in-Movimento-965316736814069/?fref=ts

8 For more information on the association see: https://www.facebook.com/baumhausbolognina/?fref=ts and https://baumhausbolognina.wordpress.com/

9 The Bolognina district is also the urban area where the research focuses for the simulation of the proposed model. As a consequence a detailed overview and analysis of this context is provided in chapter 4.

10 For more information see: http://amsterdamsmartcity.com/projects/detail/id/55/slug/the-smart-home

as innovative and that have a punctual application or use of the space: the shape of application can be drawn with a point.

- **Smart networks**. They are developed through a focus on the network

Figure 2 .5 BAUM Bolognina temporary blackboard

dimension. For example, applications of devices or technologies into the mobility (or energy) network are networks applications. For example in several cities, different kinds of projects have been already done for increasing the efficiency of mobility: from the introduction of green vehicles, to the introduction of screens for passengers information, to smart cards, enabling people to change different transport meanings without the need of changing -or buying different- tickets. As an example of an interesting and innovative project, held in Amsterdam, there is the Foodlogica project[11]: a logistical service designed to clean the last mile of Amsterdam's local food system using e-trucks instead of fuel-based vehicles. Furthermore all applications at grid level can be considered networks applications, e.g. smart grids and heating systems, can be evaluated as smart networks. An example of this is the Vehicle2Grid pilot program[12], in Amsterdam. It is an innovative project aiming to connect the use of EV with the use of energy storage systems. In conclusion, all devices, technologies, projects and approaches applied to the network/grid level can be considere as smart network applications. This typology of project can be drawn as a line or a grid of lines.

11 For more information on the project see: http://amsterdamsmartcity.com/projects/detail/id/116/slug/last-mile-logistics-foodlogica.

12 For more information see: http://amsterdamsmartcity.com/projects/detail/id/72/label/vehicle-2grid

- **Linear applications**. When projects are applied on a street dimension, it is possible to talk about linear projects. A street experiences is, for example, the Knowledge Mile[13] in Amsterdam (Renz Erich, 2015), which aims at creating, on the street level, a community and a living lab. In general, these applications are holistic strategies, involving the community and a number of stakeholders gravitating around a specific street on a city. This typology of projeccts can be drawn as a line.
- **Holistic strategies applied on an area**. They are considered the more interesting application of smart strategies or projects, because their aim is not just to address one challenge with a few instruments but to act with an ensemble of complementary strategies to achieve specific targets, regarding the selected area as a whole (Directorate-General for internal policies- European Parliament, 2014). Generally, those strategies are applied on an urban area: the entire city, a district or still a street. For entire cities applications, it is possible to evidence the experience of the holistic Copenhagen strategy to become carbon neutral toward 2050 (City of Copenhagen (eds), 2102; Copenhagen Cleantech Cluster, 2013). Copenhagen assumed that the city as a whole had a problem with climate change and decided to apply a holistic strategy, composed by several interconnected smaller projects on punctual, network or district shape. The result is a great effort made by the municipality and a great movement inside the city for implementing all projects on a specific timetable. For the district application, we can refer to several cities in Europe, such as Vienna, Amsterdam, Copenhagen, which are implementing smart projects on specific districts. As an example the St. Kield neighbourhood in Copenhagen (City of Copenhagen (eds), 2014a) proposes an integrated strategy for addressing resilience and, in particular, flooding by involving citizens, architects, planners and municipality. In conclusion, a holistic strategy applied to a selected area is formed by a complex system of projects, strictly interrelated to each other, aiming to achieve a specific target –or more than one (e.g. resilience, sustainability, social participation, and other).

The second element where it is reasonable to divide real applications of SC is the scale of application. In fact, different urban dimensions can lead to different SCs. The reason for this can be recognised into the different availability of resources, knowledge and stakeholders present in different urban scales. Three

13 For more information see: http://amsterdamsmartcity.com/projects/detail/id/136/slug/knowledge-mile-knowledge-street?lang=en

main scales application, giving different typologies of projects, are evidenced into this research, as interesting application of SCs, and can be summarised as following:

- **Metropolis / Big cities** implementation of SC approaches[14]. Big cities are one of the first contexts where SCs have been applied, mainly because of the availability of resources (both economic and human) but also for the resonance of politics and challenges. As it happens in Paris or London or Wien, European big cities tend to implement holistic strategies, covering all sectors, with a proliferation of coordinated projects, involving a large number of stakeholders and funding. Some of these experiences are interestingly analysed inside the EU report (Directorate-General for internal policies- European Parliament, 2014), where success factors are also evidenced. Into this research, the main analysed experiences are those of Paris (FR), London (UK), Wien (A) and Berlin (DE).
- **Regional / National implementation** of SC approaches. Some SCs initiatives are the reflection of a national political strength and will. In these cases, national directives can overcome several barriers in implementing new technologies or new strategies, as they are framed onto the regional or national level. In those cases, in addition, it is possible to notice how the achievement of national objectives is followed into the medium-long term, with effective and planned monitoring strategies. This typology of approach is growing in these years, in different part of Europe, and one of the more interesting process is the one followed by Denmark (see Appendix I.1).
- **Medium-sized implementation** of SC approaches. Europe is characterised by the presence of a dense territory, punctuated by many medium-sized and small cities. The diffusion of awareness about main urban challenges (e.g. climate change) and the potentialities given by a spread technological penetration makes single cities particularly active on the application of smart approaches. This evidence is, for example, clear when studying the application inside Covenant of Major program. One of the territory, which seems to be particularly aware and active into this context, is Italy where several SC projects are ongoing. This situation commonly produces several different approaches on the project, which can go from the punctual to the holistic application. Medium-sized cities are also

14 The debate about cities' classification on the base of inhabitants is complex and wide, also considering the new approach of classification introduced by the OECD (OECD, 2012). In the present research, the selection of big cities / metropolis is made considering cities with more than 1 million inhabitants.

particularly present into the winning EU H2020 funding programs SCC1-Smart Cities and Communities through lighthouse cities. In fact, on the first two calls (2014 ans 2015) 15/21 cities are under 500,000 inhabitants and only 4/21 were over 1 millions inhabitants (see Annex I.4 for the list of EU funded projects under SCC1 and FP7 programs).

The last key element, which is important to highlight as one of the main result of the case study analysis, is a consideration about SC definition. In particular, the best practise analysis puts in evidence how in Europe several approaches to urban projects are present and how objectives are wider than the few given by the SC definition. It is, as a consequence, possible to affirm that, currently, cities in Europe are going toward the SC boundaries to meet a wider Green City approach, where, with the word "Green", it is meant, in this research, the interrelation among smart, resilient and sustainable strategies, concurring together for the achievement of important objectives such as the mitigation and adaptation to climate change, the readiness in case of natural disasters but also in case of peak of energy demand, the optimisation and effectiveness of networks against resource depletion. Into the debate, the definition of smart, green and sustainable cities are separated but some studies (R. Dameri & Benevolo, 2013) and European Commission (with the H2020 Framework Program and the SETIS Roadmap) are going into the direction of integrating all these definition together. The analysis of case study give an additional evidence of this, because many strategies tends to include aspects of technology linked with low carbon strategies, green economy approaches and energy efficiency.

Several case studies can be evidenced when analysing current application of integrated SC. The research decided to focus mainly into the analysis of holistic strategies, as first step of analysis, as also the European Commission described them as more efficient and successful (Directorate-General for internal policies- European Parliament, 2014)[15]. In addition, the aim of the research is to analyse strategies for complex challenges solutions, and the holistic approach seemed to be the most pertinent. In particular, holistic strategies can be recognised for the presence of some (or all) the following elements:

- the strategy is able to create a fertile environment or to contribute to its

15 "However, a SC is more than the sum of its projects. Rather, it needs a fertile environment guided by a clear vision, the participation of relevant actors (people), and the efficient and effective organisation of its processes". (Directorate-General for internal policies- European Parliament, 2014)

creation;

- the holistic strategy is correlated by a clear vision on urban future;
- a rate of participation of relevant stakeholders or of citizens is present into the process;
- the strategy aims at answering to one of the current urban major challenges (e.g. climate change, resilience, social inclusion, economic crisis, etc.);
- the strategy deploys a collection of projects contributing to city vision or to solve selected challenges.

Inside this paragraph, three approaches are described in detail and the selection is aiming at giving an insight on the three different SCs' applications explained before: the regional, the medium-sized cities and the big cities approaches. As a limitation of the field of investigation, the research decided to take into account only European cities and not extra-European ones, even if in other part of the world it is possible to find very interesting views of SCs[16]. Further analysis could be conducted on these cases in future researches. Into the following paragraph a description for each group of cases is provided.

However, on paragraph 2.3 extends the analysis of cases and gives a first database of solutions. The filters enabling this selection have been the following:

- cities declaring to implement Smart strategies or projects (naming);

- cities implementing holistic strategies as defined by the (Directorate-General for internal policies- European Parliament, 2014)[17];

- cities with different dimensions (in term of inhabitants) were analysed;

- availability of data into the official portal or website or databases.

The following databases and sources were queryed:

- Cordis - database for European projects;

- institutional website and framework documents.

As a result, the following cities were analysed:

1) Paris, London and Milan as example of European cities with more than € 3 millions[18];

16 See for example the case of 100 SC projects in India (Ramaswamy, 2013), http://smartcities.gov.in/.

17 Into this framing document holistic strategies are considered both strategies having different projects (even not integrated or linked among them) in the main sectors of urban systems, and project having an integrated and cross-sectorial strategy.

18 The source of information were institutional website or Wikipedia, when data weren't available.

2) Torino, Milan, Reggio Emilia, Genova as example of the italian approach (selected on the basis of Osservatorio ANCI querying);

3) Copenhagen, Aarhus, Lisbon and, in general, Portugal as examples of regional approaches;

4) London, Lisbon, Milan as example of cities winning SC and Community (SCC1) H2020 European calls (see paragraph 2.3, p. 117 for some worksheets[19]).

2.2.1 National or regional approach: the case of Danish region and Copenhagen

The Denmark country has a very interesting approach on SC, as the political commitment on the national framework is very high and active onto the fields of energy and urban smart implementation. In fact, the government put in place a very precise and complete strategy to meet some ambitious targets: more than 35% of renewable energy in final energy consumption, 50% of electricity consumption supllied by wind power, 7,6% reduction of gross energy consumption in respect to 2010, 34% reduction in greenhouse gas emission in respest to 1990 (Danish Energy Agency, 2014, 2015; Danish Ministry of Climate, 2012).

The interest that the research recognises into their approach is due to the strong will that the government has, not only on an ecological/green perspective but also in integrating technologies (smart components) with sustainability and low-carbon approaches. Their commitment in energy and SC starts several years ago, in 2010, with the definition of 2020 targets. The Denmark government started to act into this direction not only for meeting the target, but with the aim of overtaking it. In fact, as the Energy Agreement and the other commitment documents affirm (Danish Energy Agency, 2014, 2015; Danish Ministry of Climate, 2012), Denmark in 2012 had already reduced by 30% the GHG emissions and they target the 37% reduction for 2020 (the EU commitment fro Denmark was 34%). For 2050, they target to complete the transition to a complete carbon neutral society.

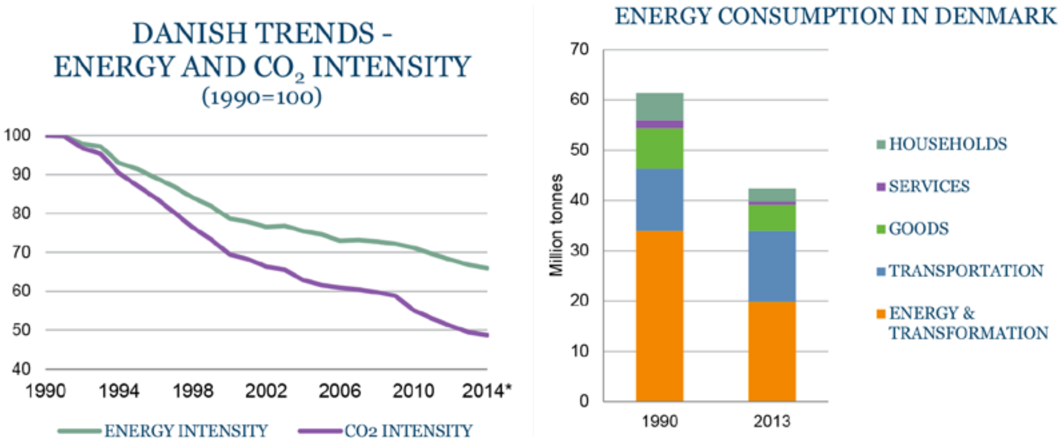
Denmark has a very specific territory, whit lot of medium-sized cities (in average with fewer than 500,000 inhabitants[20]), as common in Europe: a territory

19 The detailed description of all case studies analysed will be object of further works and publications. The research decided to do not include all descriptive boxes because the thesis is not centered on case studies analysis.

20 The World Urbanisation Prospect, in the 2011 Revision, defined for the 2025 a perspective of people living in 4 different cities size: cities with fewer than 500,000 inhabitants and cities between 500,000 and 5

formed by several medium-sized cities with some big cities, and a spread countryside whit small cities. Denmark has 5,627,235 inhabitants for 42,916 km^2 and a density of 130.50/km^2 (as a comparison, in Italy the average density is about 201.32/km^2, in the Netherlands is 407.9/km^2, in Spain is 92/km^2, in France is 99/ km^2). The population is distributed into the territory in different ways: on one side there is the capital, Copenhagen, having 1,246,611 inhabitants (data based

Figure 2 .6 Danish Trends. Source: Danish Energy Agency



on 2014), capitalizing lot of funds, stakeholders and inhabitants, then there are the other major cities: Aarhus, with 259,754 inhabitants, Odense, with 172,512 inhabitants and Aalborg, with 109,092 inhabitants (2014 data). This specificity of the Denmark territory, which is a quite small territory in respect to other countries, led the government to develop a unitary project for the whole country in the field of energy and cities.

As explained into the document (Copenhagen Cleantech Cluster, 2013), Denmark has a very conscious knowledge about its potentialities and weaknesses and this is a strong virtuous point because it leads to a conscious and effective governance and to a planned process. In fact, Denmark has a stable and ambitious political climate tradition. As already introduced, Denmark has an important and strong history into political commitment about climate change and holistic plans for improving citizens life. The first legislation and commitment into these fields was in 1925. However, not only the government is in charge for the energetic and urban implementation. There are several private-public partnerships (PPP) of

millions of inhabitant, which divide in an equal way the majority of world population; then the rest of the population is divided into cities with more and 10 millions of inhabitants and cities between 5 and 10 millions.

industries and stakeholders, very active into the implementation of innovative solutions and the creation of a stable green economy. The most famous and important one is State of Green, a consortium of public-private partnership, gathering all leading players in the field of energy, climate, water and environment. The vision that this consortium with the government share together is one: making Denmark the first low carbon country (Copenhagen Cleantech Cluster, 2013).

Then, Denmark has a leading role in testing innovative solutions, not only in term of technologies but also in term of business models. For example, Denmark is one of the leading countries in testing Smart Grids and Wind turbines. An additional important point is the highly digitalized society, with a well-developed digital infrastructure. Denmark is, in fact, the second more digitalised country after the Netherlands (in term of broadband penetration; Eurostat 2012 data). This is the result of an action plan, started in 2001, which aimed to develop a national Digitalization Strategy, mainly focused on 1) digitalizing communication between public authorities and the society; 2) implementing innovative digital services (e.g. heath care services); 3) making public and private databases compatible, with the aim of making data more integrated between the public and the private sector.

Finally, Denmark has a strong open data system and a collaborative community in gathering private data. The open data system is seen as the major enabler of the change, because it allows the development of a creative and innovative environment, where data (both public and private) are available for the development of new start-ups, apps, services, etc. Of particular interest, it is the experience of the so-called "**Data camps**", where public authorities meet private IT application developers for the creation of new IT solutions. This collaboration led to the creation of real and effective services, made by private people, with the aid and data support of the public sector. Another very interesting experience, it is the so-called "**Danish Civil Registration System**": a platform where people can share personal data. This system contains lot of information about Danish citizens, which are fundamental for supporting the public sector and its efficiency. It is explained by the municipality that people will to share valuable and personal data with public sector and other private industries in order to have more efficient services.

Therefore, Denmark has developed a collaborative and innovative environment. The collaboration among different knowledge fields is considered as one of the major challenges to be addressed. With the aim to avoid silos-thinking, they organizes the so-called "**innovation platforms**" for solving specific problems. Into these platforms, experts and entrepreneurs of different experiences and knowledge can meet each other in order to identify problems and to solve them, through and innovative approach. For now, several platforms have already started, into the field of "SC in the Oresund Region", "increased reuse of plastic waste", "increased reuse of building waste", "better digital infrastructure in Copenhagen". As a result of this policies Denmark and its stakeholders are the first in Europe in re-engineering existing technologies for smart implementation, which means being able to adapt already existing technologies, of great compatibility and communication potential, to other or new one; secondly, they possess a strong will in facilitating the implementation of public-private partnership, also with the involvement of foreign stakeholders; third, they are strong in capturing and communicating the value of smart projects to their community, which means to increase social participation, influence behaviour and create a trustful environment. However, each single project implemented into the region is asked to be evaluated and communicated in relation to the entire city and the creation of intelligent procurement processes, where also SMEs can have an easier access, is enhanced.

Into this context, the city of Copenhagen presents some interesting peculiarities. The city in fact aims to become carbon neutral (the first carbon neutral capital worldwide) before 2025. To achieve this ambitious goal, several projects and actions have been taken. The first one is the **CPH 2025 Climate Plan** (City of Copenhagen (eds), 212AD), which gives the framework for the goal achievement. The plan targets the city as an organism and defines a collection of specific actions in four major areas: i) energy consumption; ii) energy production; iii) green mobility and iv) city administration initiatives. In addition to the CPH Climate Plan, the city has implemented the **Copenhagen Climate Adaptation Plan** (City of Copenhagen (eds), 2011) aiming to address in a specific way mitigation and adaptation to climate change.

The typology of interventions implemented into the city of Copenhagen is representative of the general strategy applied inside Denmark. Also the city of Aarhus is a good example of this general strategy (p. 124).

The analyses conducted on the Danish case, put in evidence some important elements:

- first of all, the presence of a general vision for the territory with the selection of ambitious and challenging targets;

• secondly, the government is having a central role into the planning phase and into addressing funding and investments in expected activities;

• then, the presence of a cross-cutting approach and a group of collaborative stakeholders;

• finally, the selection of some primary actions where focalizing at first the attention. These actions are selected for their potential of being generator of enchaining effects.

2.2.2 Local approach: the Italian case between medium-sized and metropolitan cities

The Italian case is quite different from the Danish one. This is due to the Italian different approach on urban projects and to the presence of different iter for accomplishing them. Italy is formed by several medium-sized cities where mayors and local public sectors are often key actors for the development of innovative and smart projects (Delrio, 2013). The commitment of such projects is, in fact, often local. This approach has advantages and disadvantages. The main advantage can be seen into the diversity potential. In fact, being Italy sub-divided into very different territories, it is impossible to apply the same strategy everywhere due to geographical, social, economic, historic and climatic aspects. In addition, the local perspective enhance the involvement of citizens. However, the national commitment can boost the trnasition process overcoming local barrieres(e.g. on funds or administrative perspective, etc.). Many authors affirm the necessity of developing on a general scale targets and timing approaches for the whole territory (Delrio, 2013; The European House-Ambrosetti (a cura di), 2014). Some experiences are in fact present into the national dimension: e.g. the Osservatorio Nazionale SC with Forum PA is analysing and collecting, on a national archive, national experiences of SCs; ABB and The European House Ambrosetti have developed a research evidencing and proposing a holistic strategy for italian cities (The European House-Ambrosetti (a cura di), 2014); in 2016, therefore, the government allocates funds for SC projects implementation (65 millions of euros allocated in 2016) and subscribed in 27th October 2017 the Paris COP 21 Agenda.

Even if some national measures have been taken, it is still possible to affirm that Italy is more working into a local definition of visions and actions. As a difference with the Danish case, it is not possible to tell about an "Italian case", but more as "smaller Italian plurality of local cases". As an example, if Google Scholar database is queried, it is possible to find several examples of cities (e.g.

the Genova case, the Milan case, the Naples case, etc.) but not analysis about the "Italian case". This can also be read as the result of the urban composition of the country: lot of small and medium-sized cities and few cities with more than 200,000 inhabitants (on 8091 municipalities, only 2 have more than 1 million of inhabitants, 4 have more than 500,000 inhabitants, 10 have more than 200,000 inhabitants)[21]; of the fragmented history of the territory in itself and of the presence of different economic and social conditions in North, Centre and South of Italy.

This element can be read also into the high participation of Italian cities into the Covenant of Major platform: Italy is, in fact, the country with more cities applying into the network, in Europe[22]. This fragmentation leads to a "two speed" development: on one side there are cities implementing very innovative approaches, able to find several funds, to involve stakeholder and citizens and to be inserted into international consortia; on the other side there are lot of other cities where this implementation is still lacking and more difficult.

In addition, the country is facing also the complexity given by the new administrative division of some territories: the creation of metropolitan areas. These are new administrative entities replacing from 2015 the previous counties: Roma Capitale, Torino, Milano, Venezia, Genova, Bologna, Firenze, Bari, Napoli and Reggio Calabria. This change aimed at increasing the governance efficiency and effectiveness in territories where cities are centralized agglomerations for a bigger territory than the single municipality. In such areas it becomes clear that SC strategies need to consider the dimension of the metropolitan area rather than the single city dimension, with the aim of going toward smart lands (Bonomi, Masiero, 2014). Nowadays there are no real implementations of SC projects with this idea (at least till 2015), but some cities are starting to ratiocinate in such direction (e.g. the city of Torino in 2014 organized a conference with the title of

---

21 This data comes from the analysis of the ISTAT database related to 2011. In particular, the analysis gives the following result: 2 cities with more than 1 million of inhabitant (Roma with 2,032,175 and Milano with 1,242,123); 4 cities with more than 500,000 inhabitants (Napoli 962,003; Torino 872,367; Palermo 657,561; Genova 586,180) and 10 cities with more than 200,000 inhabitants (Bologna 371,337; Firenze 358,079; Bari 315,933; Catania 293,902; Venezia 261,362; Verona 252,520; Messina 243,262; Padova 206,192; Trieste 202,123; Taranto 200,154).

22 In fact, Italy has 3187 municipalities that have signed the Covenant of Major. Spain is the second country with 1438 signatories. In respect to them, for example Germany have 57, Belgium 224, United Kingdom 34 (data are from a personal analysis based on 2015 Covenant of Major databases).

"Toward Torino Smart Metropolitan City").

As proposed by several studies on the Italian situation (Delrio, 2013; The European House-Ambrosetti (a cura di), 2014) it is important for the country to take into account the development of transversal approaches for the implementation of effective and successful urban strategies, able to meet urban challenges on the national level with a long term perspective. The analysis conducted by (The European House-Ambrosetti (a cura di), 2014) proposes and shows in a detailed way some milestones that need to be achieved before conducting any kind of SC implementation on the local level. The readiness of the entire country is, in fact, in these studies, a major goal to be achieved for guaranteing the successfulness of actions: in their opinion ,this is the main challenge for Italy. The document proposes seven main actions for creating an organic action plan on the national level:

- to define a vision for the entire country with a specific strategy for achieving this vision. This action needs to be led by the central government as the main leading partner;
- to create a national governance for SCs able to address actions on a transversal way;
- to launch an Italian version of partnership for SC innovation;
- to create a competition with a prize for the first 5 cities which are able to meet specific targets;
- to finish and conclude definitively all actions still on-going and never concluded on the territories;
- to promote already existing smart cheap solutions;
- to define an ambitious target to be achieved.

These seven actions are selected for boosting the creation of innovation and for boosting the implementation of holistic strategies. Some of them are of great interest, as they give a specific path for the country. In particular, the definition of a clear vision and the leading role that the government need to have are the major base points for achieving a successful implementation pathway also into the European guidelines (Directorate-General for internal policies- European Parliament, 2014), as well as the definition of preliminary ambitious targets.

For implementing these actions some barriers need to be overcame into the general context:

- **social barriers**. Mainly related to the difficulties in involving citizens and stakeholders into innovative projects without a sure success. These barriers need to be overcame with a cultural and social engagement, aiming to raise the participation into all the process. With the words of Beccatini (2015) it is important to work toward the construction of the "coscienza di luogo" (see also Interview 2, Annex II.3).

- **psychological barriers** which are mainly related to the citizens' readiness in front of changes and innovations.

- **technical barriers** related to technology readiness and policy readiness.

- **governance barriers**. Mainly related to the disincline of thinking to a long term approach and to the current way of planning seeing a silos-thinking approach and a lack of integration among stakeholders (The European House-Ambrosetti (a cura di), 2014).

2.2.3 Big cities approach: the case of Paris

For analysing the case of a metropolis, the research decided to select the city of Paris[23]. The reason of this choice is to be searched into several elements: 1) the availability of information and the availability of descriptive documents; 2) the efforts that the city is putting into communicating their approach for SC development; 3) the choice of the city to focus not only into the SC, as technological implementation, but into the SC as a programmatic approach, composed by several elements and including sustainability aspects.

The city of Paris uses an approach based on one major principle named *innovation ouverte* ("open innovation"). With this principle, the city recognises to have singular specificities, leading to the necessity of providing and finding a specific way for achieving low-carbon transition, without using an already existing approach. For this reason, they implement this concept aiming at opening the availability of resources and technologies to all people, in order to trigger the change by firstly making citizens and stakeholders active and smart[24]. This

23 The city of Paris appears to be interested for investigating the approach of metropolis into the SC approach. As the research is not focused on analysing key elements only trough case study, the decision of reporting only one city/case per approach was chosen. Nevertheless into paragraph 2.3X it is possible to find some brief summaries of other cities.

24 "L'innovation ouverte repose sur l'idée qu'il faut distribuer les outils et les données au plus grand nombre plutôt que de les confiner à un seul acteur, que les solutions de demain émergeront grâce à l'intelligence collective et à la collaboration des acteurs publics, des entreprises, des chercheurs et des citoyens. L'innovation ouverte replace l'humain au cœur du dispositif en lui donnant les moyens de comprendre et de s'approprier les flux de matières et de données qui traversent la ville."(Marie de Paris, 2015a, p. 6)

principle shapes the main strategy for 2020 and beyond (Marie de Paris, 2015a) by:

1) encouraging people participation at all levels;

2) opening the availability of data and technologies to all;

3) co-constructing projects with citizens and stakeholders;

4) supporting the creation of an innovative environment and of a creative class;

5) supporting interconnections between knowledge, resources and systems.

Consequently, the aim for the city are mainly two: implementing the technologies readiness to make the participation and innovation creation possible and to improve the sustainability of the entire city.

After defining these elements, the city highlighted main barriers and challenges to be improved before 2020. These are summarised as following:

1) Energy. The city imports 98% of their needed energy, while only the 2% is produced inside the city and only half of this is from renewables. The target for 2020 is to decrease the energy consumption by 25% (in respect to 2004) and to improve the local production of renewables.

2) Vegetation and green presence. This is a specific request from citizens, to have a greener city, but it also answer to the necessity of adapting to climate change, to increase people health and to reduce air pollution.

3) Water cycle, which is important as the city has the river Seine passing through and a double system for potable and non-potable water. The water cycle needs to be improved also for avoiding flooding, which have been recurrent last years.

4) Urban agriculture. This is also an important element for citizens. The urban agriculture is already present with more than 100 shared urban gardens, 280 pedagogical gardens and 20 roof gardens.

5) Mobility. From 2011 Paris has decreased emissions linked with circulation by 30% and particulate matter by 35%-40%. Nevertheless, the city aims at completing the transition to no-diesel fuelled transport by 2020 and decrease by 40% emissions. Some projects have already been implemented and the city aims

to pursue the way started with Velib'[25] and Autolib'[26] projects.

6) Logistic. Mobility linked with logistic and good distribution is responsible of 20% or cars that drive inside the city. The target is to achieve by 202o the complete transition to electric logistic cars.

7) Other sectors are also evaluated as food, waste cycle and resilience to energetic overloads, security aspects and climate change aspects.

The city of Paris is implementing an approach based on the detailed analysis of their specific environment, potentialities and challenges. The strategy involves citizens and stakeholders from the first steps and aims at integrating different knowledge and experiences. They recognise the potentialities gave by the technological implementation, not as an objective, but as a mean for achieving major targets. In paragraph 2.3 the three integrated visions framing the urban strategy are more diffusely investigated.

The analysis conducted on best practice examples, even if it is not intended to be a quantitative analysis, put in evidence some interesting key elements. First of all, countries defining, on a territory perspective, a general strategy, based on ambitious targets, increase the creation of a fruitful environment for achieving them. General strategies are, in fact, useful for framing each single project and implementation of actions inside local territories, as they contribute toward forming a precise scenario of intervention (as in the case of Denmark). Although the local attention is still fundamental for meeting more specific local challenges and needs (as in the case of the Italian cases), as mayors and, in general, all political levels are nearer their community and they can have a direct feedback on actions (the evidence of this strength, typical of some territories in Italy is also given by interviews recorded into Annex II.3). To sum up it is reasonable to define as a success factor for SC both the presence of general framework policies, giving major national targets, and the presence of active local communities (both

25 This project started some years ago with the aim to increase the use of cycle into the city centre. With a year subscription of 19 euros it is possible to use public bikes inside the city. Bikes can be taken from specific parks, which are located into the city and they can be returned in the same park or in other parks. Maps are available as well as a smartphone application. For more information see http://www.velib.paris/

26 This project is similar to the Velib' one, but it uses cars instead of bikes. There are different rental stations inside the city and in some municipalities around the city. It is possible to rent a 100% electric car for a specific amount of time and to pay not more than 10-20 euros by months. The principle is sharing the use of a car when really people need a personal way of transport. For more information see https://www.autolib.eu/fr/

on participation and political level), adding to national target, specific action targeted to local problems. Also the report (Directorate-General for internal policies- European Parliament, 2014) records, in fact, the importance of including local context authorities and of taking under great consideration local challenges, besides national ones.

Secondly, lots of best practises are developing projects on the field of creative economy, green economy and, in general, they are activating creative-related innovations in order to boost local economies. The presence of a milieu of innovation is considered important as a triggering factor for urban development and in order to involve a large group of stakeholders inside projects, not only creative classes and communities, but also financing agencies, industries, SMEs (Cosgrave, Arbuthnot, & Tryfonas, 2013; N. Komninos, 2006; Renz Erich, 2015).

The presence of a clear vision is another successful factor for SCs with the definition of efficient processes (Directorate-General for internal policies- European Parliament, 2014, p. 76). If the development of clear visions is quite intuitive, the evolution of actual urban processes into more efficient ones, can be harder to put in practise. This is, in fact, one of the most pressing issues that need further development, with the necessity of finding appropriate monitoring instruments into a medium-long term perspective (Al-hader & Rodzi, 2009; Directorate-General for internal policies- European Parliament, 2014; Giffinger et al., 2014; Harder et al., 2014). As a result, this thesis decided to investigate more on this field of instruments for analysing and addressing strategies (see chapter 3).

Therefore, the analysis of best practises put also in evidence the absence of a strict distinction between Smart, Green, Sustainable and Digital cities, because, when cities aims to achieve the target of making citizens' life better they use indifferently ICT, vegetation and, in general, strategies for improving several aspects such as sustainability, etc. Moreover, it is assessed by (Directorate-General for internal policies- European Parliament, 2014, p. 76) that solutions meeting all these criteria in the same time are better, even if still rare.

For these reasons, the present research decided to investigate more the field of models for addressing the design of urban projects, through the use of KPIs, without being closed into the definition of SC, but going toward a wider definition including smart, resilient, sustainable and green approaches.

2.3 A selection of cases study in Europe: worksheets

The selection of case studies analysed inside the research has followed some methodological assumptions. The first limitation of the field of investigation was decided to be the European context and the second limitation has been identified in data availability (both on traditional literature sources, books, official websites and scientific paper). The third limitation has been the naming “Smart City” as the first aim of the research was to understand Smart Cities approaches.

The list of cases was selected by considering cities with more than 3 millions of inhabitants, with the aim of identifying key elements in big cities. Then cities inside winning Smart Cities and Communities (SCC1) Horizon 2020 program have been analysed. Finally a number of italian cities have been selected on the basis of the Osservatorio Anci archive (in particular the first 15 cities with more projcets on going). Into this paragraph, the research collects a selection of worksheets as described in the following table.

City	Inhabitants	Keywords	Worksheet
Paris	10,869,000	holistic approach, big city, vision	n° 05, page
London	7,615,246	big city approach, strong analysis on current situation	n° 07, page
Milan	3,890,000	big city approach, high innovation rate on projects	n° 06. page
Berlin	3,700,000	ambitious targets, holistic approach, clear vision	n°10, page
Copenhagen	1,246,811	holistic approach, clear vision, extended GC approach	n°01, page
Turin	890,529	high presence of stakeholders, governance support, holis-tic approach	n°03, page
Aarhus	318,757	societal challenge, creative environment	n°02, page
Lisboa	496,343	regional/national approach, strong analysis on current situation, high presence of stakeholders	n°08, page
Reggio Emilia	171,237	creative environment, holistic approach, Italian case, medium-sized city	n° 04, page
Genova	585,081	Italian case, history and analysis ot the context	n°09, page

CASE STUDIES	n°01

THE CITY OF COPENHAGEN

BEING THE FIRST CARBON NEUTRAL CAPITAL IN 2025

City main data

Inhabitants: 1,246,611

Average density: 6,607.39 ab./km²

Innovative aspects

1) Presence of a clear vision

2) Integration of actions inside a general strategy

Action main data

Project year: from 2010

Type of action: Top down

Stakeholders involved: The city involves several stakeholders from policy makers, to industries to the community.

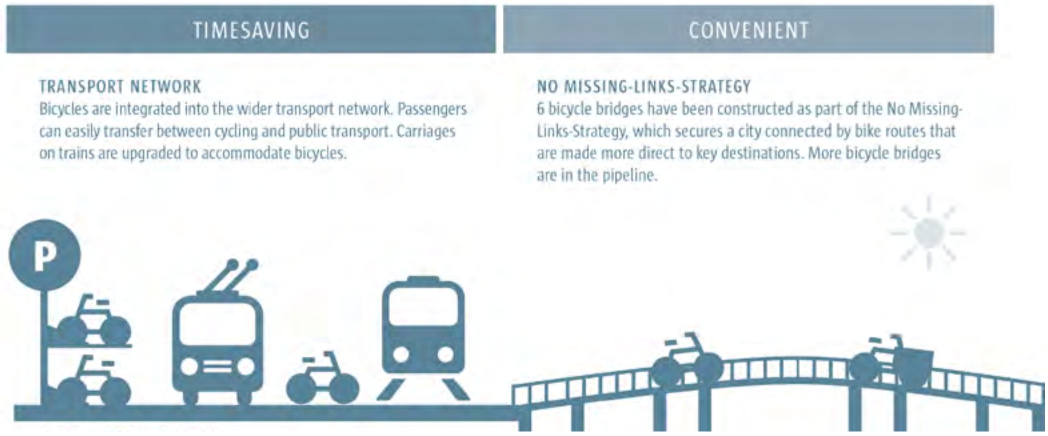
Funds: ND

Main actions The city of Copenhagen defined an holistic strategy for the achievement of their ambitoius target of energy efficiency, transition to renewables and to low-carbon society, as defined into the policy document (City of Copenhagen (eds), 2014b). The city is implementing a wide range of strategies both on the field of Smart and Green Cities, which, as defined into this work, it includes smart, resilient and sustainable strategies. Therefore, the main strategies, under application inside the city, are divided into 4 milestones: mobility, water, energy and resources. These actions are framed inside a holistic strategy.

Main sources: (City of Copenhagen (eds), 2014b)

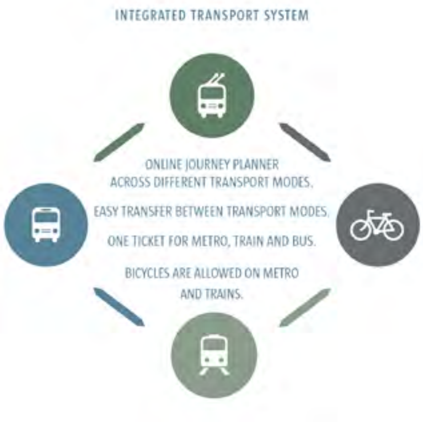
CASE STUDIES n°01

THE CITY OF BIKES AND INTEGRATION OF ALL MEANS OF TRANSPORTS



Mobility

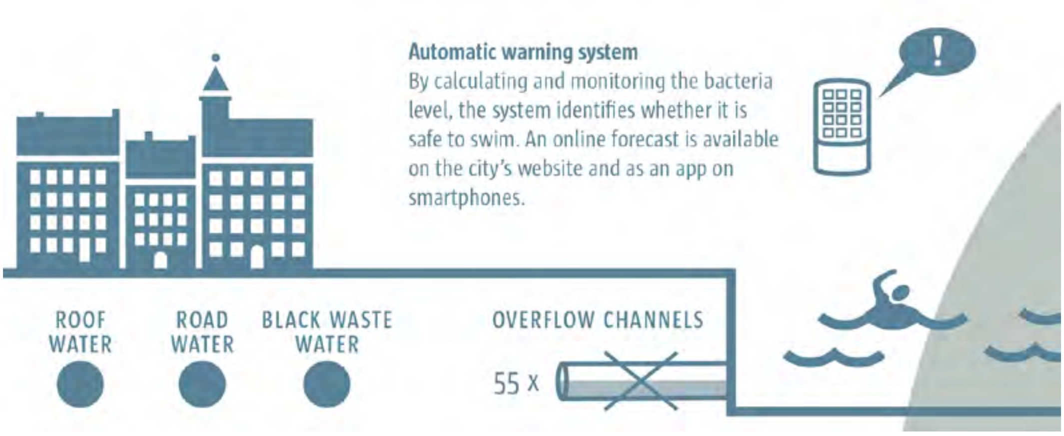
The main focus for the mobility sector is the cycling mean of transport. In fact, the city aims to make cycling the major mean of transport before 2050. In particular, their target is to increase the number of commuters cycling to work and schools from 35% in 2011 to 50% in 2025. In 2014 the rate was already at 45% (City of Copenhagen (eds), 2014b, p. 7). This attention to the cycling system has improved citizens' health and has reduced traffic congestion, as well as air pollution. 140 millions of euros saved in healthcare were assessed because of the use of bikes as people main mean of transport. The strategy were not only to implement the physical infrastructure, but also to: i) make street safer and to increase the sense of safety; ii) cycle tracks uninterrupted; iii) easy transfer to public transport services; iv) increase of comfort in using this mean of transport. The second element focused by the municipality was the real integration of public transport, not only among trains, buses and metro, but also with operator and applications. As result of the investments for achieving this target, the city reduced the CO_2 emissions due to road transport to less than 350.000 tonnes in 2014. Therefore. the strategy included the use of ICT devices in order to increase the connectivity of the physical infrastructure with citizens and to improve accessibility and facility in using it. Some of these devices allows people to access infrastructure information, to have only one ticket for all means of transports, to plan trip online and being texted on smartphone about it, etc.



COPENHAGEN

CASE STUDIES	n°01

CLEAN HARBOUR, DRINKABLE TAP WATER, FLOODING PREVENTION



Water

The harbour was for citizens the most polluted area into the city, due to the past use of the water and the old sewage system. Today, the harbour has been completely cleaned-up, with an investment aiming to modernize the sewage system and the wastewater treatment, to implement a cleaning strategy (concerted among all stakeholders), diverting local rainwater, the creation of recreational spaces along the harbour. This strategy makes the site one of the trendiest places, where it is possible to bath and have recreational activities and even new jobs were created due to the opening of services and the increase of real estate prices. In addition, a smart system informs citizens if the air quality is not sufficient for bathing. Related to water other two aspects the city is taking into account: the drinking water from the tap (100% of tap water can be drank) and flooding prevention.

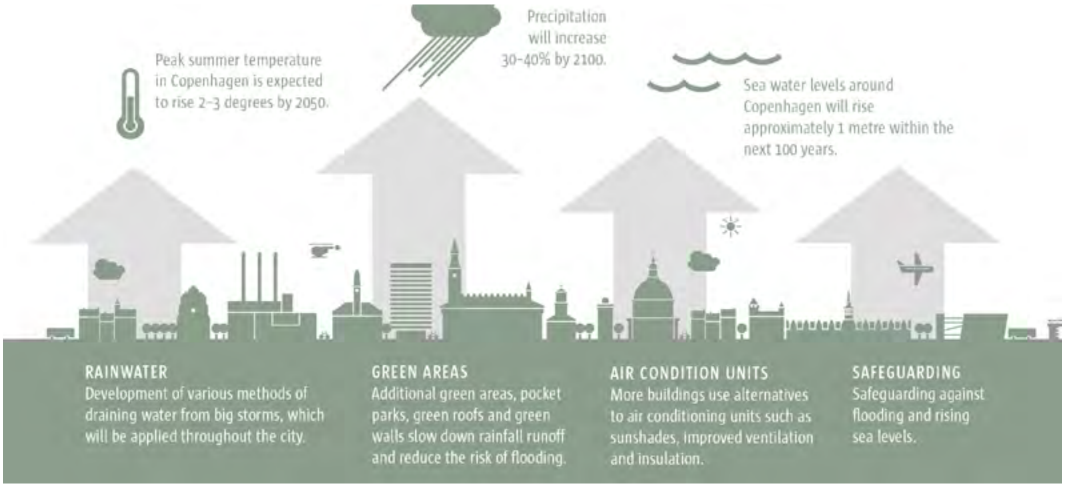
Energy

Energy sector is focused mainly on the wind turbine technology. The investment is related to the infrastructure implementation, the high-class technology and the community ownership, which make citizens aware and involved into energy savings and renewable energy improvement. Due to this strategy, the total electricity consumption produced by wind turbines has increased from 22% in 2012 to 39% in 2014.
Waste management is the second main aspect addressed in the city. The aim is not only to recycle but also to reuse waste as resources, in order to achieve in 2050 the no-waste target. A series of flagship project are undergoing into the city to solve specific waste treatment projects. The third main element is the implementation of district heating systems, to which 98% of households are connected, in order to de-carbonise the district heating. Investments into the sector are related to technologies implementation, as CHP (Combined Heat and Power) systems, the main use of biomass as sources. Then, the implementation of a district cooling system which use seawater and saves

COPENHAGEN

CASE STUDIES	n°01

SYSTEMS INTEGRATION



Energy

70% of energy in comparison with traditional air-conditioning. Finally, sustainable and retrofitted buildings. The strategy is threefold and integrated: building new buildings as NZEB ones, making old buildings energy efficient and retrofitted and implementing a certification system.

Integration

All the previous actions are deeply integrated into a full strategy composed by several elements and planning instruments: at first a strategic urban plan, aiming to correlate social behaviour and citizen well-being with energy related challenges; a series of plans for achieving the ambitious target of being carbon neutral before 2050 and a strategy for adaptation to climate change.

COPENHAGEN

CASE STUDIES	n°01 bis

ST. KJELD NEIGHBOURHOOD

AN EXAMPLE OF FLOODING PREVENTION

District main data

Roads surfaces: 270,000 m²

Potentially green surfaces: Potentially 50,000 m²

Innovative aspects

Flooding prevention actions with both passive and active technologies. Passive: rain gardens and increased vegetation. Active: rainwater collection and transport toward the harbour.

Action main data

Project year: from 2012

Type of action: Top down with a strong community participation

Stakeholders involved: Municipality, citizens, Tredie Natur's Architecture, GHB Landscape Architects, Orbicon

Funds: ND

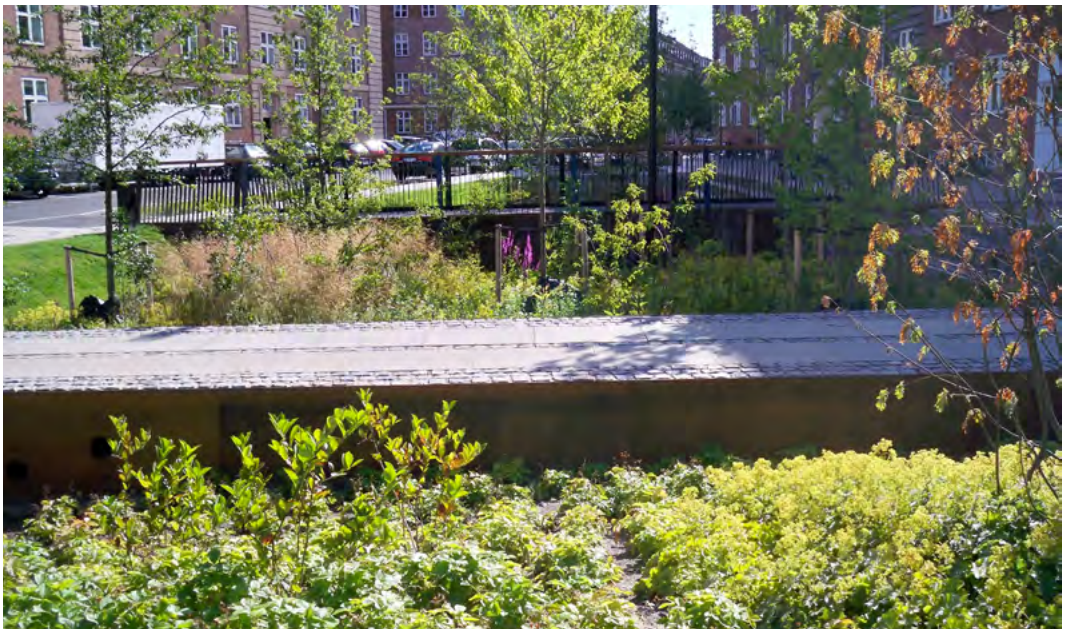
Main actions The neighbourhood is located into the Osterbro district, which is an evolving district of the city. Historically, the neighbourhood was a classic working-class area, with brick buildings and a high density. The district met several problems mainly linked to flooding, many times during the winter. This was caused by the enormous presence of asphalt and the totally absence of vegetation and green surfaces, a result of the car-centred lifestyle. Flooding created several management and safety problems, as well as uncomfort and environmental decay. The municipality, with the involvement of citizens, into a real participatory approach, was able to make this area the first resilient and energy efficient area into the city.

Main sources: (City of Copenhagen (eds), 2014a); http://www.dac.dk/en/dac-life/copenhagen-x-gallery/cases/the-st-kjeld-climate-district/; http://www.orbicon.com/News.397/T%C3%A5singe-Square-%E2%80%93-Copenhagen%E2%80%99s-First-Climate-Adapted-Urban-Area.762.aspx

CASE STUDIES n°01 bis

Integration

Main actions were taken in order to achieve the resilience and flooding prevention target. Starting from the analysis of ceiling permeability situation, the designer defines a master plan where big place is given to actions targeted at increasing the ceiling permeability (increase green surfaces and reducing street sections; adding gardens at the street corners and in correspondence of places and playground areas; implementation of rainfall gardens where the rain is collected and slowly channelled into the sewage system or reused or channelled into the harbour).



ST KIELD NEIGHBOURHOOD

CASE STUDIES	n°02

THE CITY OF AARHUS

SMART INITIATIVE: INNOVATION AND PARTICIPATION

City main data

Inhabitants: 318,757

Average density: 679,65 ab./km²

Innovative aspects

Digital technology is mainly used to solve societal challenges, such as security, participation, increased creative environment, solution of physical space related problems

Action main data

Project year: from 2012

Type of action: Top down

Stakeholders involved: Municipality, citizens, universities, business community, public sector

Funds: ND

Main actions The city of Aarhus launched in 2012 the Smart Aarhus initiative, aiming to become a model, both internationally and nationally, for urban development based on partnership and to be a test facility for SC solutions and a showroom of projects. This target was achieved through the real citizen participation and stakeholders involvement, through a cross-disciplinary approach. Different solutions were tested and lot are currently under testing. The main objectives chosen by the city were to solve social challenges (mainly related to resource scarcity and mobility problems) and to strengthen the digital economy for creating new jobs. These objectives are pursued with some key-points:

Main sources: http://www.smartaarhus.eu

CASE STUDIES n°02

the collaboration among all involved partners, in order to challenge the traditional role of citizens, public sector and private enterprises; being open and involving stakeholders; being experimental by using pilot-projects. Some of the actions and solutions are explained following.

Events A number of events are implemented into the city to make participation more effective and pleasant. Some of the events are: the Internet Week Denmark (a Festival celebrating the Internet); Counter Play Festival (a Festival for Playfulness); Aarhus 2017 EU Capital of Culture; the Media Architecture Biennale.

Open Data Creation of an Open Data portal to enhance the diffusion and collection of information and sharing of services.

City Lab Working groups and creative environment are organised in some areas of the city through the creation of creative labs.
(See for further information http://www.smartaarhus.eu/node/132)

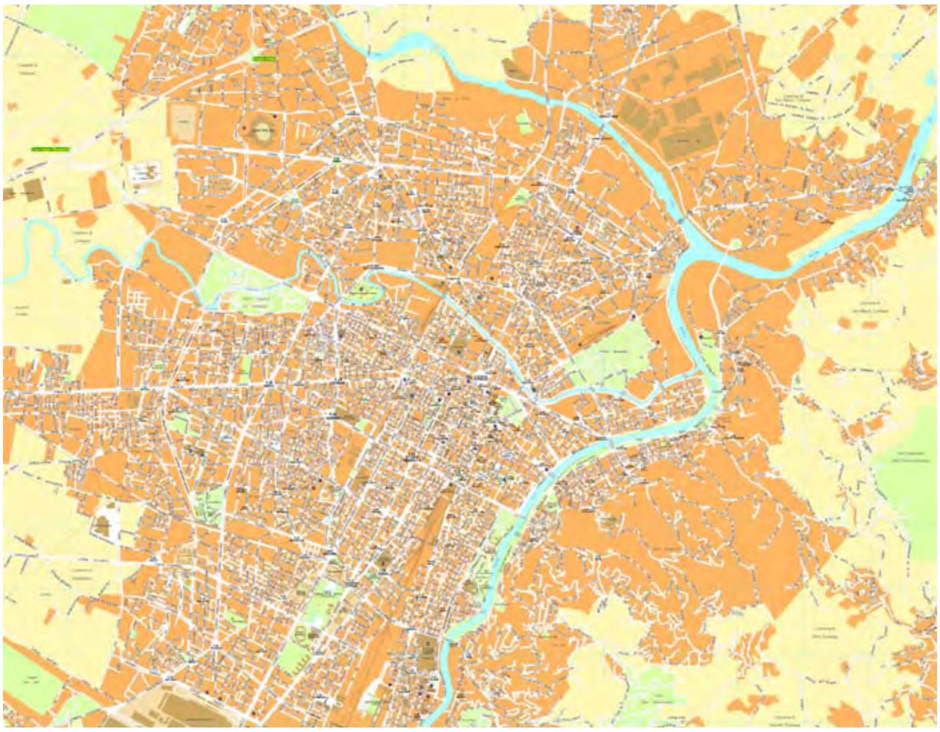
Smart Drones The city is using drones for several aims: implement the open data catalogue, improve the security of the city, monitor urban conditions (e.g. traffic); monitor citizen participation.
(See http://www.smartaarhus.eu/node/188).

Neighbourhood The Digital Neighbourhood project (2014-2016) analyses how people can interact with the urban environment by providing several information and interactive application into different neighbourhoods.

AARHUS

CASE STUDIES	n°03

THE CITY OF TORINO



INNOVATIVE TECHNOLOGIES AND MASTER-PLANNING

City main data

Inhabitants: 890.529

Average density: 6 848,59 ab./km²

Innovative aspects

1) Definition of plans and policy documents as the main framework for action implementation

2) Presence of a variety of projects and actions

3) Deep involvment of stakeholder

Action main data

Project year: from 2009

Type of action: Top down

Stakeholders involved: academia, industry, social community and political institutions

Funds: € 248.689.107,74

Projects n°: more than 78 (finished or on-going)

Main actions The city of Torino signed in 2009 the Covenant of Major initiative, and approved in 2010 the Turin Action Plan for Energy. In 2011 they participate into the European Smart City Initiative, which led to the creation of the Torino Foundation for Smart Cities and Sustainable Development. Into this project different cities stakeholders are included and they participate together for implementing and discussing projects for the city. The municipality with the Foundation start in 2013 an important project, "SMILE - Smart Mobility Inclusion Life & Health and Energy", where more than 66 stakeholders participated (from academia, to industry, to social community and political institutions). This

Main sources: http://www.comune.torino.it/geoportale/pums/cms/; http://www.comune.torino.it/ambiente/; http://www.comune.torino.it/trasporti/bici/presentato-il-piano-della-mobilit-ciclabile---bici.shtml; http://www.italiansmartcity.it/city_detail.php?city=001272; http://www.torinosmartcity.it/torino-smart-city/la-vision/

CASE STUDIES	n°03

project is perceived by the city as the main triggering project, because from this they create an integrated master plan for the city, which is today the reference for the implementation of all the other initiatives. The Master plan is based on 45 actions articulated in objectives as following: efficient and sustainable mobility; efficient and effective energy and resource use; open, inclusive and user-friendly society; high life quality; tourism attraction; investments on digital services.

Cruscotto Sicurezza Urbana (from 2011)

This action implemented a study on the theme of people security into the city. With a composed strategy made by monitoring systems and participative approach, the project is able to give data to the municipality in order to implement the security and the citizens' sense of safety.

Smart School Plan (from 2012)

This action aims to work inside schools for giving a sustainable and low-carbon education to youth. In particular, into schools the action implemented three main themes to deal with: Smart Retrofit, Smart Carbon and Smart Community.

Definition of a key policy strategy

Urban Plans for Sustainable Mobility and the Energy Plan with the Biciplan – The plan for Cycle Mobility- are three important documents written by the municipality in order to frame, in such major sectors, the transition toward a low carbon city.

TORINO (IT)

CASE STUDIES	n°04

THE CITY OF REGGIO EMILIA

REGULATION IMPROVEMENT AND INNOVATION SOCIETY

City main data

Inhabitants: 171 237
Average density: 742,38 ab./km²

Innovative aspects

1) Ongoing definition of a holistic approach
2) Creation of a creative/innovative/productive environment as one of the main strategies fo SC

Action main data

Project year: ND
Type of action: Top down
Stakeholders involved: academia, industry, social community and political institutions
Funds: € 31.214.350,25
Projects n°: More than 26 projects (finished or on-going)

Main actions The city of Reggio Emilia is implementing from many years an idea of SC based on the creation of a basic framework able to guide the further development of single project. They in fact believe into the definition of a holistic approach and, overall, into the upgrading of policies and urban plans. On the practical point of view, the city of Reggio Emilia, which can be considered as a medium-sized city (less than 200,000 inhabitants), is focusing mainly into the improvement of the built environment and into the strengthening of a sense of an engaged community. This last element is pursued through the diffusion of social innovation. For funding this strategy the municipality participated into different EU funded projects, as well as into regional ones.

Main sources: http://osservatoriosmartcity.it/reggio-emilia/
http://www.italiansmartcity.it/city_detail.php?city=035033

CASE STUDIES	n°04

Smart Mobility

The city has several projects inside the mobility sector, aiming to improve the sustainability of the entire system. The project Mobility 2.0, for example, is aiming to complete the transition to an electric mobility inside the centre of the city. This project adds inside electric cars an innovative sensors system able to communicate with the charging stations and to give additional information to the driver. Of great interest is also the Foot project, which aims to improve the space for pedestrians.

Smart Environment

The project involves a big industrial brownfield located in the city centre of Reggio Emilia: the Officine Reggiane. A big regeneration process is already started and saw the creation of a technical and industrial pole for researching in innovation: the Tecnopolo.

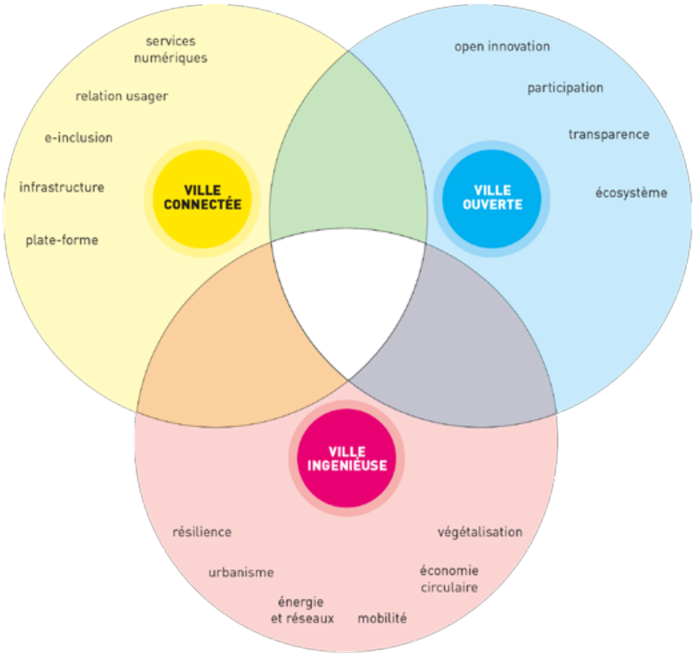
Smart Economy

The Smart Economy sector is one of the most implemented, because of the great interest that the city has into the development of a creative industry. In fact, they are implementing a project named TRAIN-ER for the creation of a diffuse hub, named NEXT STOP, working as an incubator for start-ups and innovative businesses. In parallel, different Fab Lab are growing into the area.

REGGIO EMILIA (IT)

CASE STUDIES	n°05

THE CITY OF PARIS



A STRATEGY DEVELOPED THROUGH 3 CITY VISIONS

City main data

Inhabitants: 2,229,621	
Average density: 21,153.9 ab./km²	

Innovative aspects

1) Presence of a strong vision framework for the future city development and a clear view
2) Definition of a holistic approach

Action main data

Project year: ND
Type of action: Top down
Stakeholders involved: The city involves several stakeholders from policy makers, to industries to the community.
Funds: < € 680 millions
Projects n°: ND

Main actions

The general strategy adopted into the city follow three pillars which explicit three visions of the city:
1) ville ouverte (=open city)
2) ville connectée (=connected city)
3) ville ingénieuse (=smart / clever city)

Ville ouverte = Open city

The fist approach of ville ouverte focuses on the participation potential inside the process, through:
- opening public structures and academia to researchers both French and international;
- involving citizens through co-work and working groups
- strengthening the innovative environment and the development of a creative society.

Main sources: Marie de Paris, 2015a, 2015b

CASE STUDIES — n°05

Open city in numbers	
500 millions	Euros devoted to projects inside this pillar
100,000 m2	Additional space for innovative and creative industry
+30%	Foreign start ups inside Paris incubators (target for 2020)

Ville connectée = Connected city

The second approach of ville connectée focuses on modernisation and technologies implementation in a crosscutting dimension. In fact, the implementation is made in all urban sectors by:
- implementing the physical infrastructure;
- increase people knowledge on using technologies;
- opening a database for make data transparent;
- opening online services for citizens and enterprises;
- opening the access to technologies to the highest number of people.

Connected city in numbers	
180 millions	Euros devoted to projects inside this pillar, activated through the Schéma Directeur Ville Numérique 2015-2020 (Marie de Paris, 2015b)
2,000 WiFi point	To be implemented in the city

Ville ingénieuse = Clever/smart city

The third approach of ville ingénieuse focuses on questioning the functioning of the city from the perspective of energy, climate mitigation, economy, waste, innovation, social inclusion and systems interconnections.

Open city in numbers	
90,000 buildings	Connected to a central monitoring system
1,200 boilers	Renovated and connected to a monitoring system
103 km2	Modelled in 3D
1,000 buildings	Retrofitted under the energy perspective
25%	Improvement in renewables production before 2020
0 plastic disposable bags	Used for waste
-15%	Of domestic waste production before 2020 (in comparison with 2007)
100% of bio-waste	Collected and efficiently recycled inside public buildings
-60 %	Of GHG emissions from mobility before 2020 (in respect with 2007)
50%	Of the total good logistic made with electrical cars before 2020
+60	Of new electric charging stations, near the already existing 700, before 2020
1,400 km	Of total cycle lane (today are 700 km)
30 km/h	As speed limitation inside city (excluding highways and ring roads)
+100 ha	Of green roofs and façades. 10 ha of them are conceived for urban agriculture
+200	Public places which will become greener
-30 ha	Of green public space
+1	Plan for mitigation to climate change

PARIS (FR)

CASE STUDIES	n°06

THE CITY OF MILANO

PROJECTS FOR INTEGRATION AND INNOVATION ENVIRONMENT

City main data

Inhabitants: 1 350 387
Average density: 7 433,19 ab./km²

Innovative aspects

1) Big city approach and definition of an holistic vision
2) EU project participation and high innovation in several projects

Action main data

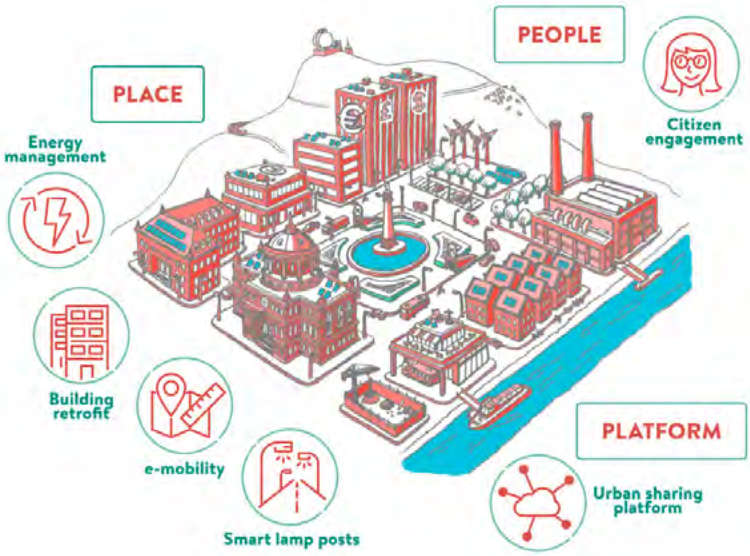
Project year: from 2012
Type of action: Top down with participatory approaches
Stakeholders involved: institutions, citizens, university, non-profit sector
Funds: € 128.679.858,01
Projects n°: 81 projects (finished or on-going)

Main actions

The city of Milano started to think about becoming smarter from 2012 when different task-forces and working groups were created in the traditional six smart themes (environment, mobility, living, people, economy, governance). An additional task force was, then, created for meeting the challenge of the EXPO 2015 organization. The main aspect of Milano strategy is linked with the aim of the municipality to create a fruitful environment for growth, both on economic and social perspective. Below some projects are listed. However, the strategy is mainly developed under the living, mobility and governance sectors.

Main sources: http://www.italiansmartcity.it/city_detail.php?city=015146; http://www.sharingcities.eu/; http://www.milanosmartcity.org/joomla/

CASE STUDIES n°06



Sharing City Horizon 2020 SCC1 funded project	The Sharing City project involves three cities as lighthouses: Milano, London and Lisbon. The aim of the project is to demonstrate smart solution through deep retrofitting, mobility and ICT implementation. Milano implement strategies on a district: the Porta Romana - Vettabbia area. The renewal of the area is under development and, in particular, the following actions are expected: 25,000 m^2 retrofit (of which 4000 are public buildings), 62 e-cars, 150 e-bikes with 14 stations, 60 charge points, 300 smart lamp posts, 1 social housing car sharing and a Smart city lab with data storage. The figure above presents the main strategy of the project.
Boosting Social Innovation - Urbact III project	The project is aimed at increasing social innovation and integrated strategies development inside European Cities. The first phase of the project saw, in Milano, the publication of the White Paper on Social Innovation - Accelerating Milan's local ecosystem for social innovation.
MYC – Milano Young Citizens project	The project aims at boosting active participation of youg people into urban transformations, thorugh the development of new start-ups and SMEs.
Open Care Horizon 2020 funded project	The project aims at implementing innovation in citizens healthcare. In order to increase the effectiveness of people care, the city decided to involve creative people, artists, designers on a co-creation lab.
OPTI-LOG - OPTImal and sustainable LOGistics in urban areas project	The project, funded by regional investmenst program POR-FERS, aims at developing new applications for city logistic efficientcy.
S[m2]ART project	The project, funded by MIUR program, aims at developing smart street furniture able to enhance end-users usability of the public space.

MILANO (IT)

CASE STUDIES	n°07

THE CITY OF LONDON

LONDONERS AT THE CORE: CREATIVITY AND ENABLING TECH

City main data

Inhabitants: 8 673 713

Average density: 5 517,1 ab./km²

Innovative aspects

1) Presence of deep analysis on 2016 London State of the Art aimed at highlighting key sectors of development

Action main data

Project year: from 2012

Type of action: Top down with high participation rate

Stakeholders: academics, municipality, businesses and entrepreneurs

Funds: ND

Projects n°: ND

Main actions The city of London has developed a complex strategy for achieving the smart transition of the city. Several documents show the potentialities of the urban context in achieving challenging targets through the use of enabling technologies. A big attention is put into enabling citizens to use new digital devices and to propose applications for a deep communication between citizens and the City Hall. An analysis has been developed by ARUP in order to gain a deep insight on the 2016 state of the art. Energy is one of the most important sector where achieving smart solutions is important, as e.g. London accounts for nearly 10% of the electricity consumption in the UK.

Main sources: http://www.london.gov.uk/sites/default/files/smart_london_plan.pdf; https://www.london.gov.uk/sites/default/files/arup-gla-smart_city_opportunities_for_london-160620-lowres.pdf

CASE STUDIES n°07

Sharing City Horizon 2020 SCC1 funded project

The Sharing City project involves three cities as lighthouses: Milano, London and Lisbon. The aim of the project is to demonstrate smart solution through deep retrofitting, mobility and ICT implementation. London implements strategies on the Royal Borough of Greenwich: an area of 516 ha. Innovative smart lighting system, with building retrofit and new e-vehicles are expected to be placed under the project.

Londoners at the core

One of the main London strategy is to make londoners at the core of the strategy. Several measures have been taken in order to achieve this goal, to engage people in political life, to increase knowledge on digital services, etc. For example Talk London is a digital place were citizens can discuss about city challenges, problems and when new city vision are presented.

Access to Open Data

The existing London Datastore is planned to evolve in one of the most advanced online platform for several uses. Data can be in fact used by several users: citizens, to gain information about the city, but also industries and stakeholders.

Creativity and culture

Creativity and culture is enhanced with investments aimed at increasing creative people access to start-ups, SMEs and digital jobs.

Enabling technologies

Enabling technologies installation is aimed at increasing services (mobility, traffic congestion resolution, etc.) on the city but also efficiency (smart grid to better manage demand and supply for energy and water). The development of 3D visualization of the city (also on underground) is also brought forward.

LONDON (UK)

CASE STUDIES	n°08

SMART CITY PORTUGAL

PORTUGAL NATIONAL STRATEGY FOR A SMART TERRITORY

City main data

Inhabitants: 10.341.330 (Lisbon: 547 631)
Average density: 113,50 ab/km² (Lisbon: 6442,72)

Innovative aspects

1) Presence of deep analysis of potential national stakeholders
2) National/Regional approach

Action main data

Project year: -
Type of action: Top down
Stakeholders: academics, municipality, businesses and entrepreneurs
Funds: ND
Projects n°: ND

Main actions

Portugal has started a national strategy for Smart Cities implementation inside their territory. In particular, they built a Smart City Portugal Collaborative Platform with the aim of grouping stakeholders present inside the territory on a task force group for actions implementation. This process is of particular interest as they start from a deep mapping analysis on relevant stakeholders, including research centres, academia, industries, service companies, etc. They, in fact, start from the wish of making Portugal a testing environment for new Smart solutions. Objectives of the platform are the following: promoting the development of Smart Cities pilot projects, stimulating the scaling up of innovative solutions, forster the participation of Portuguese cities inside EU funded projects, promote the internationalization of Portuguese companies inside the SC market, enhance the creation of new companies and start-ups in the field, evaluate the impact of actions on job creation, wealth, people wellbeing, national economy. The Strategic Area to which the Platform is targeted are the following: internationalization,

Main sources: http://www.inteli.pt/uploads/documentos/documento_1400235009_2055.pdf

CASE STUDIES n°08

R&D and innovation, entrepreneurship, funding, and regulation. Some interesting actions and project which are ongoing inside Portugal, are listed below.
Portugal has also been the territory of the greenfield PlanIT development. It is also important to note that Lisbon is a funded city under the Sharing Cities EU SCC1 project. In particular the city developed the start up implementation program named Smart Open Lisboa (see Figure).

aLIVEPlaces (3D Decide)

This is an urban 3D project, allowing cities to share 3D information to citizens both on urban level (with the 3D visualization of space) and on private level (with the possibility to share indoor location but also data about inside temperature. This tool is available on smartphones and pad.

iParque (ACIN iCloud solutions)

This is an already operative parking tools inside many cities in Portugal and Spain. It allows end-users to gain information about parking and to pay in advance.

Simplicity (AIRC)

This is a platform software for supporting local authorities and decision makers in planning interventions inside cities. It helps in analysing data, anticipating problems and coordinate actions and resources. It allows planning in several domains such as the following: infrstructure, governance and social dimension.

Interactive city (Artica Creative Computing

This is a permanent exhibition where visitors can interact with the city (at first commissioned by the city of Almada) and play a role game through the past, the present and the future of the city. The interactive environment gives the visitants an insight on urban dimension and collective memories.

PORTUGAL

CASE STUDIES	n°09

THE CITY OF GENOVA

GENOVA AMBITION OF BEING AT HUMAN SCALE

City main data

Inhabitants: 585 081
Average density: 2 434,9 ab./km²

Innovative aspects

1) creation of an association as the main starting point
2) Potentialities given by history and specific Mediterranean context

Action main data

Project year: -
Type of action: Top down
Stakeholders: academics, municipality, businesses and entrepreneurs
Funds: € 118.858.901,34
Projects n°: 50

Main actions

The city of Genova is developing an approach on smart cities through the creation of the Association Genova Smart City and the implementation of more than 50 projects. The city aims to support a transition toward a city at human scale, in the field of energy, social inclusion (with specific attention to elders and people affected by disabilities), fight against resource depletion and improvement of a cultural model for boosting innovation. They developed a vision for the city developed into a decalogue involving the following points:
- Mediterranean city: beautiful and bright. The presence of the Mediterranean Sea is seen by Genova as an important key factor for recovering specific traditional values and cultures typical of the city history. The dialogue between new smart cities approaches and the sea need to be different in respect to other EU cities (e.g. on the North) as the Mediterranean Sea bring specific challenges and potentialities.
- Planning and Integrated Management. An integrated planning among creativity, cul-

Main sources: http://www.comune.genova.it/tutte-le-notizie/120; http://osservatoriosmartcity.it/genova/; http://www.italiansmartcity.it/city_detail.php?city=010025

CASE STUDIES **n°09**

ture, energy efficiency and people wellbeing is pursued by the municipality and the association with an high integration rate between disciplines and stakeholders.

- Energetic awareness.
- Simplification of urban services for all kind of citizens and end-users, over all those with specific challenges (elders, disabilities, childre, etc.)
- Information access.
- Respect for diversities and social inclusion
- Youth study and work program. The city is implementing actions for addressing young people toward the access to green economy market and job position, by boosting the access and the quality of research and high technologies education.
- Excellence to be pursued inside projects and actions with a regard to scaling-up and replicability of solutions.
- Relation between sea and harbour. The city aims at implementing actions centred on the seaside and the harbour, for example the creation of a green seaport, the study of eolic energies, etc.

Some of the most interesting project actually ongoing are listed below.

Decision Theatre	Funded by the MIUR inside the program Fondi nazionali Bando MIUR Smart Cities and Communities (D.D. del 5 Luglio 2012 prot. N. 391/Ric.), the project aims at creating a cloud platform for creation, validation and composition of data and complex models. The objective is to create a data platform able to support long-term decision making.
Electric network and multimodal parks	The city installed 17 new EV charging points for citizens and car-sharing and new multimodal parks where people can leave their own vehicle and use public transport. The car-sharing has also been implemented through the collaboration with Enel distribuzione.

GENOVA (IT)

CASE STUDIES	n°10

THE CITY OF BERLIN

MAKING HIGH LIFE STANDARD USING LESS RESOURCES

City main data

Inhabitants: 3 531 201
Average density: 3 959,41 ab./km²

Innovative aspects

1) Definition of ambitious target and definition of a holistic and integrated strategy
2) Presence of a clear vision of the city future and of the role of technologies

Action main data

Project year: from 2012
Type of action: Top down
Stakeholders: close collaboration among public administration,private entreprise and science
Funds: (2014-2020) 635 M.European Funds for the regional development

Main actions From the European creation, in 2012, of the European Innovation Partnership on Smart Cities and Communities, the Germa government and Berlin started to think about making cities smarter. The city set the smart city discourse around the idea of creating a high life standard cities with less use of resources. In particular, they define a urban management system that, with the use of ICT and technologies, aims at linking various sources of information in order to create synergies; aims at achieving a significant increase of efficiency through the application of integrated approaches; aims at creating high life levels with the involvement of investors and citizens into the process. With this idea of future, the city defined a series of objectives, as listed following: 1) climate neutrality of Berlin by the year 2050, with the increased use of RES and the reduction of non-renewable resources; 2) "A minimisation of the negative side-effects of living in a densely populated urban environment, such as environmental pollution, stress-related illnesses or a diminished feeling of personal safety"; 3) development of economy and

Main sources: http://www.smartcity.tu-berlin.de/; http://www.berlin-partner.de/en/the-berlin-location/smart-city-berlin/

jobs and international competitiveness; 4) creation and boosting of a lead market for innovative products and innovation; 5) regional and international perspective; 6) increasing of urban infrstructure resilience; 7) “long-term securing and optimising of public services through public administration, municipal enterprises and social bodies”; 8) increase the culture of transparency in PA; 9) increase of quality of life and location; 10) increase in social participation.
The use of technologies, mainly efined by the city as ICT technologies, is part of the process but still far from being the centre of the strategy. The technology is, in fact, perceived as an enablers which must stay on end-users and citizens control. Following a list of most interesting actions inside some of the main sectors of application is provided. The main sectors are smart administration and urban society, smart housing, smart economy, smart mobility, smart infrastructure and public safety. These Actions are defined as cross-sectorial with the aim of avoiding silos-thinking.

Smart administration and urban society

- Creating a modern administration by avoiding silos-thinking and by increasing participation;
- Speeding-up ans simplifying administrative processes with the support of IT + creation of E-Government
- Simplification thorugh digitalization of business creation and maintenance processes
- Open data and social integration

Smart housing

- Housing politics measure in order to make houses affordable at all level of society + measures to maket houses secure, workable for all people and qualitative (the Urban Development Plan 2025 will build new 137,000 flats with a goal of 10,000 new flats every year)
- Technological support on housing policies through FIS Broker geographical data portal, extensive use of BIM
- Develpment of existing housing stock, adapted for new needs, both on life and energetic point of view + new Smart Homes creation + implementation of tele-job
- Development of an Ambient Assistant Living for people with disabilities
- Energy efficiency refurbishment at the neighbourhoo level (see the experience of the Mariengrün Quarter

Smart Economy

Smart Economy is mainly pursued through boosting innovation at several levels (from industries to new start-ups), through the collaboration with universities and research centres and by boosting internationalisation.

Smart Mobility

Smart Mobility is intended as a precondition for increasing social participation, as citizens life is based on the possibility of moving from one place to another. The city developed a Urban Development Plan for Trasport 2025, where several actions are expected. Among them the implementation of traffic systems, the boosting of sharing experiences, etc.

3 Cities indexes and models. A Key Performance Indicator approach

Different approaches are present when applying SC strategies into real contexts, as described in chapter 2. How these approaches are evaluated? How it is possible to measure urban performances, while applying Smart or, more wider, Green Cities? Several instruments are present: indexes, rating systems but also application of international labels defining different sets of indicators and key elements for evaluating project's results and urban performances.

The chapter aims at investigating indicators usually used for analysing smart and green projects, both at the urban and at the district/neighbourhood level.

It is structured in three parts: the first one analyses the theoretical framework underpinning the use of Key Performance Indicators; the second one describes a selection of main assessment and rating instruments as well as models and labels using indicators as means for evaluation. The last part interprets the analysis of all instruments by selecting a panel of KPIs conceived as the most interesting for addressing the design of Green cities.

The sources used to achieve the aim are: i) conference paper, books, journal articles, master and PhD thesis referring to KPIs; ii) rating and assessment instruments and international labels; iii) international guidelines (UE or OECD).

The main questions this chapter aims to answer are the following:

- Which are the main indicators used for evaluating Smart and Green Projects?
- Which are the most interesting indicators for addressing the design of

Green Cities, on a ex ante perspective and for monitoring results on a long term perspective?

3.1 Key performance indicators: a theoretical framework

Indicators are defined as *"quantitative or qualitative measure derived from a series of observed facts in a given area"* (OECD, 2008) useful for summarising, simplifying and communicating complex phenomena (EEA, 2005; European Environment Agency (EEA), 2014). In fact, using indicators is considered useful, as complex phenomena can be hardly defined and controlled, withouth simplifications. Hence indicators are also useful for identifying trends, drawing attention onto specific aspects of selected topics, addressing policies priorities and monitor effects on different time bases (OECD, 2001). Even if simplification can be considered as positive for analysing complex systems and phenomena, too much simplification can be negative: as argued by (Meadows, 1998) indicators can be poorly chosen and this can lead to several problems (e.g. Meadows explains the gaps caused by the use of GDP as the main indicator for society well-being. See (Meadows, 1998, pp. 19–20). Therefore, indicators are usually the reflection of a single portion of reality with selections based upon uncertain and imperfect models. Even more, the definition of a single indicator or a single index is hardly seen as a reflection of wide analysis, but it's more seen as the interest about specific aspects of the topic (Meadows, 1998). In the case of SCs, for example, some scientists can be more interested on ICT-based strategies, some other on sustainable one, etc. For this reason, indicators need to be chosen following different rules and trying to observe and describe the reality in its complexity.

As a first useful distinction, the European Environment Agency (EEA) defines the nature of indicators in (European Environment Agency, 1999). They divide them in 4 typologies:

- **Descriptive indicators** describing the actual situation with regard to main environmental issues. They answer the question: What is happening to the environment and to humans?
- **Performance indicators**. "They compare actual conditions with a specific set of reference conditions. They measure the 'distance' between the current environmental situation and the desired situation (target): 'distance to target' assessment." They answer to the question: Does it matter?
- **Efficiency indicators**. "Most relevant for policy-making are the indicators

that relate environmental pressures to human activities. These indicators provide insight in the efficiency of products and processes" They answer the question: Are we improving?

- **Total welfare indicators**. They describe the total system in respect of sustainability. They answer the question: Are we on whole better off?

Even if these typologies are related to sustainability, the same distinction can be related to other themes such as the Smart or the Green City. Inside this research, the focus is mainly on performance indicators and descriptive indicators. Different rules can be applied when proposing indicators. As described by Gabrielsen and Boch (Gabrielsen & Boch, 2003) and more recently in some European reports on defining indicators for sustainable cities (European Commission & Science for Environment Policy, 2015) the main purposes of environmental indicators may consist in:

- being able to detect real environmental problems in order to enable policy-makers to evaluate the impact and the change on a timesheet;
- providing guidance for policy development to mitigate pressures on environment;
- giving the methodology for monitoring the effectiveness of policy actions and responses to the detected challenges;
- raising a public awareness about the issue.

Several systems also use the SMART criteria: specific, measurable, available or achievable in a cost effective way, relevant for the program, and available in a timely manner. For analysing current systems using indicators some main sources have been studied:

- documents about sustainable and smart indicators (Gabrielsen & Boch, 2003; Green Growth Knowledge Platform, 2013; Hammond, Adriaanse, Rodenburg, Bryant, & Woodward, 1995; Lombardi et al., 2012; OECD, 2001, 2008; United Nations, 2007)
- PhD and master thesis specifically related with indicators (Dizdaroglu, 2013; Martin, 2013)
- rating systems (BREEAM, 2012; Charoenkit & Kumar, 2014; GBC, 2015)
- ranking systems (Between (a cura di), 2014; Forum PA (a cura di), 2015)
- European projects (Giffinger & Fertner, 2007; Giffinger et al., 2014; Giffinger, 2015)

3.2 Smart models and indexes analysis: ex-ante and ex-post approaches

Several models investigating urban performances are available. This research decided to focalize on different typologies of instruments in order to gain the most complete overview of indicators as possible. Nevertheless, instruments were selected considering the nature of approaches and preferring those defining a structured and holistic vision for urban environment. This selection is not to be intended as a systematic evaluation of all models and approaches existing, but as a qualitative representative selection, on an international point of view. 24 total models were analysed divided in ranking instruments (4), EU projects (2), awards (2), thesis (2), tools (1), certification instruments (6) and complete models (7). The analysis of these instruments put in evidence two main levels of knowledge: on one side *ex ante*[1] models, which gives the reflection of an investigation about processes; on the other side *ex post*[2] models, which gives the reflection about KPIs for evaluating and measuring strategies. Into this paragraph both analysis are pursued.

Ex-ante models analysis

The research analysed six instruments developed into important institutions and researching centres in USA, Europe and Italy. The first four of them are developed in USA or Europe although the last two are specific for the Italian context. Figure 3.1 shows the investigated instruments.

All these instruments give an approach on Smart, Green or Sustainable cities, aiming at focusing some specific key features. For example **The Urban Nexus**, developed by ICLEI[3] (Local Government for Sustainability) in collaboration with GIZ[4] (Deutsche Gesellschaft fur Internationale Zusammenarbeit), develops a model aiming to accelerate the process toward more sustainable cities and for making stakeholder engagement more effective. This model proposes, in

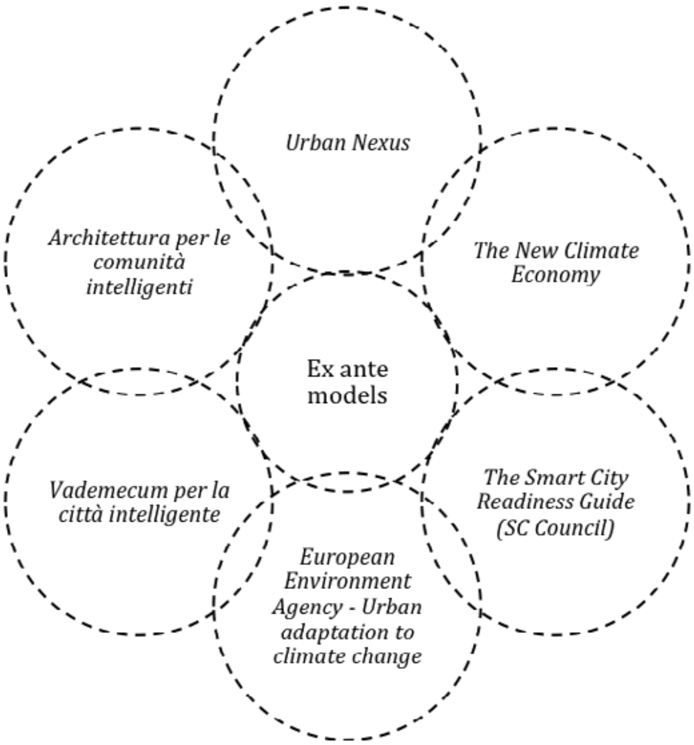
1 With ex ante it is intended a model aiming to address the definition of a strategy or an action chronologically before the beginning of the process.

2 With ex post it is intended a model aiming to evaluate a project or a strategy after its accomplishment.

3 See: http://www.iclei.org/urbannexus.html

4 See: http://www2.giz.de/urbanet/focus/urbannexus.asp

Figure 3.1 Ex ante models analysed



fact, a set of guidelines for designing sustainable urban development solutions. One of these instruments, it is the optimisation of decision making process, by guiding stakeholders and policy makers around workshops, round tables and task forces. *"The approach guides stakeholders to identify and pursue possible synergies between sectors, jurisdictions, and technical domains, so as to increase institutional performance, optimize resource management, and service quality"*(GIZ & ICLEI, 2014). As the citation highlights, the model proposes a cross-sectorial approach for stakeholder involvement against the actual silos-thinking approach.

Another interesting model, aiming to accelerate the transition of cities toward more equitable and sustainable systems, is the **New Climate Economy** one. This is a flagship project of the Global Commission on the Economy and Climate[5], undertaken by seven countries: Colombia, Ethiopia, Indonesia, Norway, South Korea, Sweden and the United Kingdom, in order to examine how countries can achieve economic growth while dealing with the risks posed by climate change. The NCE Cities Research Programme is led by LSE Cities[6] at the London School

5 See the website: http://newclimateeconomy.net/

6 See the website: https://lsecities.net/objects/research-projects/new-climate-economy

of Economics. They propose a model based on three pillars: the 3C model. The 3C stay for *compact, connected and coordinated* urban development. With compact it is intended a compact urban growth where expansion and urban retrofitting is managed at the highest governance level. Into this pillar, they propose to encourage *"higher densities, contiguous development, functionally and socially mixed neighbourhoods, walkable and human-scale local urban environments, the redevelopment of existing brownfield sites and provision of green spaces"* (Floater & Rode, 2014). With connected they mean connected infrastructure, in order to promote innovative ways to consider infrastructure, with a great interoperability and integration, but also with the use of innovative technologies (such as Bus Rapid Transit, cycle superhighways, electric vehicles, smart grids, energy efficient buildings and essential water, sanitation and waste services). The third pillar is the coordinated governance necessary for addressing the change and a more integrated urban development.

Unlike the previous two models, conceived as general model, the **SC Readiness Guide** is conceived as a more practical planning manual. It is developed by the SC Council[7] (USA) still with the aim of accelerating the transition toward SCs. The importance of this planning instrument is the collaboration that the Council is having with some of the most important ICT companies all over the world, ensuring a deep comprehension of the current ICT and technologies development. Hence, this guide is mostly technology/market oriented. The guide proposes a step-by-step approach where the definition of a preliminary vision (or, as they call it, "wish list") is the starting point for the development of any strategy. They define a cross-sectorial and interoperable framework compose by SC responsibilities (built environment, energy, telecommunications, transportation, health and human services, waste and wastewater, public safety, payments) and SC enablers (instrumentation and control, connectivity, interoperability, security and privacy, data management, computing resources, analytics). The guideline aims to help cities in finding a holistic strategy with a clear definition of a vision ("where you want to end up?") and of a timing approach ("where you should start?") (Berst, Enbysk, Williams, & Caine, 2013). This model is one of the main reference for this research, as it focuses on a step-by-step approach, which can be easier to follow by designers and decision makers. As the SC Readiness Guide, in

7 See the website: http://smartcitiescouncil.com/

Italy the Osservatorio Nazionale SCs,[8] in collaboration with Forum PA[9], developed the **Vademecum per la città intelligente**: a planning manual aiming to give operational and practical indications for the implementation of smart strategies into Italian cities. The importance of this report deals with the analysis of Italian context and its potentialities as well as with the operative structure of the report in itself.

Urban adaptation to climate change in Europe is a report developed by the European Environment Agency[10] aiming to implement efficient and effective strategies for the SC development. The report addresses stakeholder involvement in urban development in order to support policy development and decision-making process. The importance of this report deals with the lecture of the SC phenomenon and with the proposition of an integrated methodology for the application of adaptation strategies to climate change into the built environment and the urban context. A similar approach undertakes the **Architettura per le comunità intelligenti**: an Italian reference report, proposed by the Agenzia per l'Italia Digitale[11], with the aim of addressing the technological implementation into Italian urban contexts. Table 3.1 summarizes the main characteristics for each model analysed, pointing in addition their importance for the research.

The *ex ante* models analysis put in evidence several common points:

- the importance for an integrated vision when defining an applicative model for cities development, which is also one of the findings coming out from the best practices analysis (see chapter 2) and (Directorate-General for internal policies- European Parliament, 2014, p. 76);
- the integrated structure of a SC approach, which is not defined by the sum of a series of project, but more as a holistic preliminary vision, then composed by a group of smaller projects;
- several approaches can be used for guiding a city into a smart development, and the main elements which is necessary it contains are stakeholder engagement, resources management, timing approach, economy, mitigation and adaptation to climate change;

8 See the website: http://osservatoriosmartcity.it/

9 See the website: http://www.forumpa.it/

10 See the website: http://www.eea.europa.eu/

11 See the website: http://www.agid.gov.it/

Table 3. 1 Summary of main analysed models

Name of the model	Authors
The Urban Nexus	**ICLEI**
Main points:	
- Methodology to accelerate the process for future and more sustainable cities. - Definition of a step by step approach - Definition of ways for achieving a real stakeholder involvement and collaboration - Avoid silos-thinking and improve cross-sectorial approaches	
Importance for the research:	
- Comprehension of a methodological structure and of key elements - Comprehension of how translate a process for a SC into a complete methodology - Comprehension of the SC phenomenon - Comprehension of the importance to have an integrated approach	
The New Climate Economy	**LSE**
Main points:	
- Proposition of a 3C Model for sustainable urban growth where compact urban growth, connected infrastructures and coordinated governance are the main pillars for a sustainable urban development	
Importance for the research:	
- Focus on cross-sectorial problems and challenges for cities	
The SC Readiness Guide	**SC Council**
Main points:	
- Definition of a step-by-step framework - Analysis of SC potentialities, needs and barriers	
Importance for the research:	
- Framework for smart methodology	
Urban adaptation to climate change in Europe	**EEA**
Main points:	
- Focus on urban adaptation to climate change	
Importance for the research:	
- More insight in urban adaptation to climate change models	
Vademecum per la città intelligente	**Forum PA**
Main points:	
- Definition of challenges for the Italian context - Definition of main feature for the development of SC strategies	
Importance for the research:	
- Approach for the Italian specific context	

• some difficulties still exist in understanding how to simplify and really accelerate the decision making process, however three aspects seem to be fundamental: the definition of a vision, the integrated approach, the timing approach (no transformations can be done in one year).

The ex post models selected can be reasonably divided into four groups: ranking instruments, certification tools, EU funded projects and award applications. The aim of those models is to evaluate, in a holistic way, already existing projects with two different objectives: for ranking models the aim is to compare different cities and projects (comparative approach), for certification tools to evaluate a specific action (analytic approach).

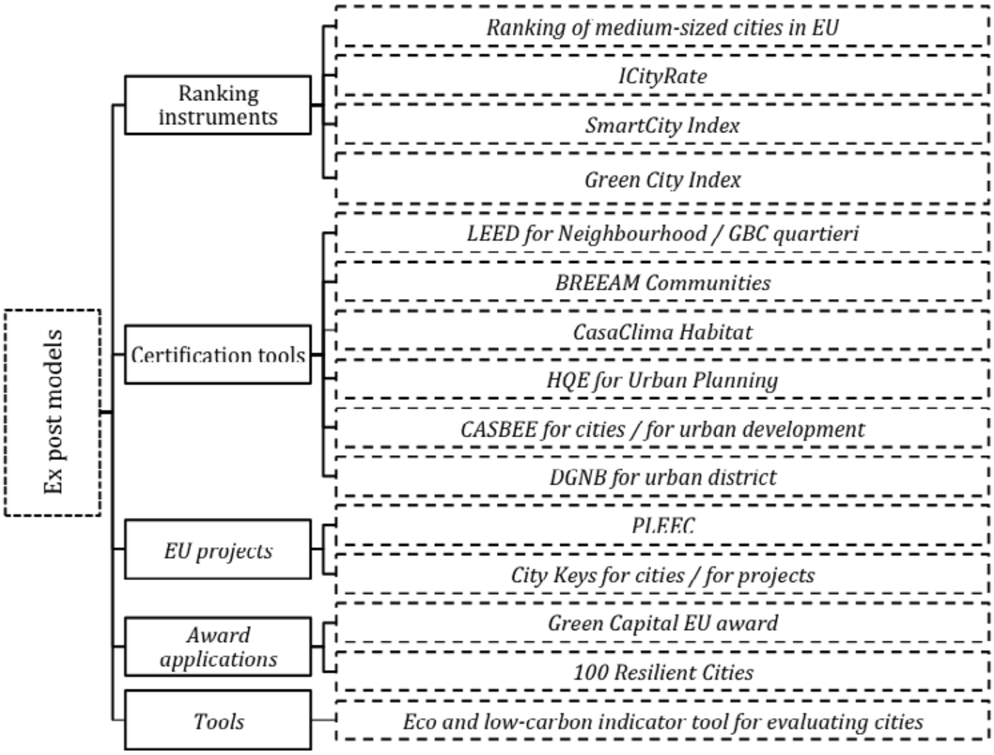
Ex-post models analysis

For the ex post models the research analysed 15 models in total: 4 ranking instruments, 6 certification tools, 3 EU projects, 2 award applications and 1 tool.

Many other instruments are available into the literature but the research decided to focus on the most used instruments having protocols for the application on district level, in Europe or in Italy. In addition, the analysis was focused on instruments developing a complete set of indicators, useful for understanding main key indicators. Figure 3.2 shows the selected instruments.

Ranking instruments aim to compare several cities and signal the most virtuous one. In the field of SCs, one of the first ranking instrument was developed by (Giffinger & Fertner, 2007) with the name of **Ranking of medium-sized cities in Europe**, being the result of an academic research. They developed not only the ranking with a point system, but they also collect data from several medium-sized cities in Europe into their website, http://www.smart-cities.eu/. This model divides indicators into six main groups of smartness: economy, people, environment, governance, mobility, living. In 2015 they also implemented a ranking for larger cities. Groups were then divided in 28 domains and in 81 components or indicators. As an example, the environment group contains indicators about air pollution, environmental conditions, ecological awareness and sustainable resource management; while Living is more addressed to creative, cultural, touristic, health and buildings conditions and People is addressed to the analysis of social composition in term of multi-cultural and levels of education. This ranking instrument is also part of the European project **PLEEC**, where groups evolved in a 5-based monitoring indicators groups including green buildings (with 6 indicators covering the share of thermal renovation, the presence of NZEB

Figure 3.2 Ex post model analysed



and data about population density); mobility and transport, which contains 16 indicators covering from CO_2 emissions, to pedestrian and bicycle penetration, to the parking systems; technical infrastructure with 6 indicators going from waste infrastructure, to smart meters, to district heating; production and consumption, with 9 indicators going from energy demand and CO_2 emissions in industry, to service sector to household income spent on petrol or electricity; to energy supply, with 13 indicators going from solid fuel, to biomass, to solar (Fertner, Groth, Groszse, Read, & Rocco, 2014; Giffinger et al., 2014; Giffinger & Strohmayer, 2014).

As the Ranking of medium-sized cities in Europe, also **ICityRate** and the **SC Index** are two ranking instruments. The ICityRate is an Italian ranking developed by Forum PA and built on the basis of 7 groups of indicators: legality, economy, living, environment, people, mobility, governance. It starts from the same groups of the Giffinger model, adding some indicators and the main group of legality. The other main difference with the other rankings is that the ICityRate develop each main sector with 2 sub-groups of indicator, the first one being the analysis of the normal performance of the sector, the second one giving the additional analysis on smartness. So, for example, the sector Living is composed by 6 traditional indicators and 6 smart living indicators: the first group evaluate aspects going from healthcare and eldercare to education, to social cohesion, while the Smart Living group evaluate aspects such as culture, sharing economy, and connective infrastructure. In the same way, the "traditional" Environment includes indicators going from energy consumption, to green space availability, while the Smart Environment investigates from eco-management aspects, to waste management and air control (Forum PA (a cura di), 2015). The SC Index, instead, is a ranking developed by Between with the Italian Digital Agency. They define the SC as a fluid, friendly, connected, clever and simple city and they develop a model based on 9 thematic areas: smart health (analysing the presence of connected and digital healthcare system), smart education (analysing digitalization in schools), smart mobility and smart government (both analysing the digitalization of sectors), broad band, alternative mobility (which includes EV and mobility sharing and pooling), energy efficiency (smart buildings and smart lighting), renewables (photovoltaic, Aeolian, hydroelectric) and natural resources (waste, water, air management) (Between (a cura di), 2014).

Quite different in respect to the previous one is the **European Green City Index**, developed by Siemens. The main difference is the target: previous instruments targeted specifically SC, while the Green City Index targets green cities, with means that the investigation is not about digitalization and technologies but about sustainability, vegetation, resource depletion, etc. (R. Dameri & Benevolo, 2013). This index divided indicators in 7 groups: CO_2, energy, buildings, transport, waste and land use, water, air quality and environmental governance (Siemens, 2012). For a complete analysis on green indexes see (Meijering, Kern, & Tobi, 2014), which it is also an interesting study on the field of methodologies and transparency used by rankings.

Certification tools are numerous and cover a wide range of methodologies and application all around the world. From some years, quite all major certification agencies are reflecting about how to extend their product not only on the building dimension, which is their primary object of evaluation, but also on the urban dimension, focusing on the district/neighbourhood dimension and, more rarely, on the entire city (as the case of CASBEE Japan). The research investigates 6 instruments. It is possible to say that the majority of the analysed instruments are structured in similar ways with a specific focus on architecture and construction and, overall with a general focus on new districts instead of acting on existing one. In fact, for example, **Green Building Council** (GBC) for cities (inside the LEED program) identify 5 steps of analysis of projects applied to the district dimension divided in the following groups: localisation and site connections (including indicators of mobility, accessibility, natural resources); organisation and design of the district; infrastructures and sustainable buildings, design innovation and regional priorities (GBC, 2015). Different in respect to the other certification tool is the **CASBEE for cities**, developed in Japan, which focus the attention on the entire city as a complex system to be analysed and evaluated. The tool is based on the definition of an index (BEE) based on the ratio between Urban Quality and Environmental Load. Indicators are referred to these two elements, which gives the main index. Urban Quality is calculated with indicators divided in environmental quality, economic quality and social quality; while the environmental load is calculated on the basis of the annual CO_2 emissions per capita (CASBEE, 2015). An additional point of interest of this certification tool is the inclusion of a scenario analysis. CASBEE is, in fact, reflecting not only in evaluating the state of the art of cities, but also in addressing the design of actions inside them. In order to make this design more conscious and aware, the tool uses the same expression with quality and load on a scenario perspective: so designers can calculate the BEE index in different scenario of intervention and decide which is the best solution for the analysed city. This element is interesting and important as it focus on future of cities and tries to give a scientific methodology for choosing the most suitable scenario.

The FP7 and H2020 Framework Program from 2014-2015 included both several program for SCs and Communities projects. The aim of the commission was to enhance studies on this field in order to develop effective strategies for the implementation on cities. Under this momentum of great interest by the commissions, several projects born on the topic. One of the most interesting is the **City Keys project**, which aims to find KPIs for SC evaluation. This project is on-going and the analysis of its deliverables highlight how indicators are not only focused on the digital/technological part of urban system, but more on integrated approaches among sustainability and smartness. In fact, they divide the selection of indicators in 5 main sectors: people, planet, prosperity, governance and propagation. People group includes indicator about health (with innovative indicators describing “encouraging an healthy lifestyle” and “waiting time”); safety (including cyber security); access to services (e.g. “quality of public transport” but also “improved access to vehicle sharing solutions); education (e.g. digital literacy and environmental awareness); diversity and social cohesion (e.g. increased participation of vulnerable groups); quality of housing and the built environment. The Planet group includes energy and mitigation; materials, water and land; climate resilience (estimated through the Likert scale); pollution and waste and ecosystem. The Prosperity group includes employment, equity, green economy (with green public procurement), economic performances, innovation, attractiveness and competitiveness. Propagation investigates the replicability and scalability potential and the factor of success. This project has interesting points of innovation to be taken under consideration.

To sum up, key performance indicator used for the evaluation of sustainable, green or smart projects are many and they cover a wider range of themes and sub-themes. In Figure 3.3 an analysis of the distribution of indicators in the different sectors is provided, while a more complete list of indicators is provided in worksheets in paragraph 3.3. Eight main themes were identified:

- **economic related indicators**, including production and consumption and green economy;
- **people related indicators**, including also culture, health, education, integration, employment and social equity;
- **buildings / living related indicators**, including also land use (this is because the most part of the models analysed consider together living and land use), location, linkage and quality of the location, density;
- **environment related indicators**, including also ecology, energy and resources;
- **mobility indicators**, including traffic and transport in general;
- **governance related indicator**s, including also process analysis, innovation, adaptability and replication;
- **technology / ICT related indicators**;
- **Legality / security related indicators**.

The graph puts in evidence several elements:

- main indicators (in term of number) are mainly distributed on three axis: people, environment and governance. The major result is indeed for people related theme. In fact, each ranking and rating systems consider the people theme as one of the main category to be addressed by SC projects. In addition, they generally provide a large number of indicators for this section. Moreover environment and governance are perceived as main elements to be addressed by SC instruments and tools.
- The ICT/technology sector is, surprisingly, one of the less developed themes. The reason can be the difficulties of linking market availability with real

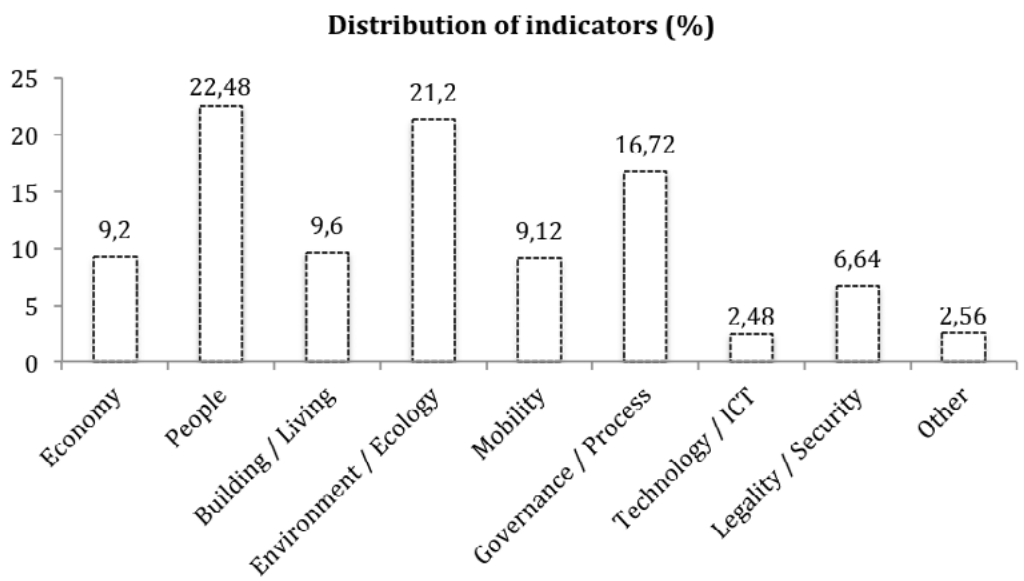
implementation and real funding potentialities.

- Economy, living and mobility are perceived as medium analysed themes, to be addressed by strategies and to be monitored, even if the most part of projects actually available are applied into these sectors.
- Finally, a big part of indicators is also related to legality and security, which is one of the increasing sector cities need to address.

Also two final works were analysed, proposing indicators, which are considered interesting for the development of the research (Dizdaroglu, 2013; Martin, 2013). Both are thesis trying to identify indicators for sustainable and SCs and they have been taken under consideration for the definition of a new set of indicators, trying to overcome barriers among smartness, green and sustainability approaches.

It is reasonable to conclude that, actually, there is no complete set of indicators able to completely address and guide communities into the transition from fuel-based districts to smart and green one. However, analysing in detail each instrument, it is possible to find some groups of recurrent and important indicators which are always used and which are perceived as fundamental for

Figure 3.3 Distribution of indicators in analysed instruments (%)



addressing such strategies. This selection is the basis for the main result of this thesis and it will be presented in the Conclusion of Section 1.

3.3 Smart models and indexes analysis: worksheets

WORKSHEET - KPI MODEL	**n°01**

RANKING OF MEDIUM-SIZED CITIES IN EUROPE

Model main data

☐ Ex ante model
■ Ex post model

■ Ranking instrument
☐ Application for certifications / labels / awards
☐ Rating instrument
☐ Thesis
☐ EU H2020 project
☐ Tool

Innovative aspects and strenghts

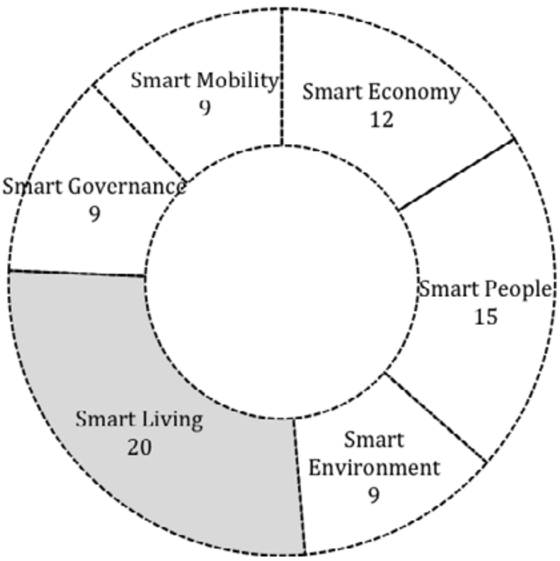
- Medium-sized cities
- One of the first smart city ranking study
- Presence of several editions
- Wide set of indicators divided into groups

■ Presence of KPIs
☐ Presence of step-by-step approach
☐ Presence of scenarios

Authors and scope

The ranking is developed due to a research developed by TU Delft, Vienna UT and Lubjana universities, with the objective not only of defining a ranking among cities in Europe but also to reflect about indicators.

Indicators distribution graph



Weak points

The main weak points are, in opinion of this reasearch, the following:
- at first, the absence, inside open source documents, of units of measure, which makes the replicability and model understanding more difficult
- secondly, indicators are inhomogeneous in respect to selected themes and subthemes

Main sources: http://www.smart-cities.eu/

Key performance indicators

Theme	Sub-theme	Indicators
Smart Economy	Innovative spirit	R&D expenditure in % of GDP; Employment rate in knowledge-intensive sectors; Patent applications per inhabitant
	Entrepreneurship	Self-employment rate; New businesses registered in proportion of existing companies
	Economic image & trademarks	Importance as decision-making centre
	Productivity	GDP per employed person
	Flexibility of labour market	Unemployment rate; Proportion in part-time employment
	International embeddedness	Companies with HQ in the city quoted on the national stock market; Air transport of passengers; Air transport of freight
Smart People	Level of qualification	Importance as knowledge centre; Population qualified at levels 5-6 ISCED; Language skills
	Affinity to life long learning	Book loans per resident; Participation in life-long-learning in %; Participa-tion in language courses
	Social and ethnic plurality	Share of foreigners; Share of nationals born abroad
	Flexibility	Perception of getting a new job;
	Creativity	People working in creative industries
	Cosmopolitanism/Open-min-dedness	Voters turnout at European elections; Immigration-friendly environment; Knowledge about the EU
	Participation in public life	Voters turnout at city elections; Participation in voluntary work
Smart Governance	Participation in decision-ma-king	City representatives per resident; Political activity of inhabitants; Importan-ce of politics for inhabitants; Female city representatives
	Public and social services	Expenditure of the municipal per resident in PPS; Children in day care; Perception of quality of schools
	Transparent governance	Perception on tranparency of bureaucracy; Perception on fight agains corruption
Smart Mobility	Local accessibility	Public transport network per inhabitant; Access to public transport; Quality of public transport
	(Inter-)national accessibility	International accessibility
	Availability of ICT-infra-structure	Computers in households; Broadband internet access in households
	Sustainable, innovative and safe transport systems	Green mobility share; Traffic safety; Use of economical cars
Smart Environment	Attractivity of natural con-ditions	Sunshine; Green space share;
	Pollution	Summer smog; Particulate matter; Fatal chronic lower respiratory diseases
	Environmental protection	Individual efforts on protecting nature; Opinion on nature protection
	Sustainable resource mana-gement	Use of water per GDP; Use of electricity per GDP
Smart Living	Cultural facilities	Cinema attendance; Museums visits; Theatre attendance
	Health conditions	Life expectancy; Hospital beds per inhabitant; Doctors per inhabitant; Perception on quality of the health system
	Individual safety	Crime rate; Death rate by assault; Perception on personal safety
	Housing quality	Share of housing fulfilling mininal standards; Average living area per person; Satisfaction with personal housing situation
	Education facilities	Students per inhabitant; Access to the educational system; Quality of the educational system
	Touristic attractivity	Importance of tourist location; Overnights per year per resident
	Social cohesion	Perception on personal risk of poverty; Poverty rate

WORKSHEET - KPI MODEL	n°02

ICITY RATE

Model main data

☐ Ex ante model
■ Ex post model

■ Ranking instrument
☐ Application for certifications / labels / awards
☐ Rating instrument
☐ Thesis
☐ EU H2020 project
☐ Tool

Innovative aspects and strenghts

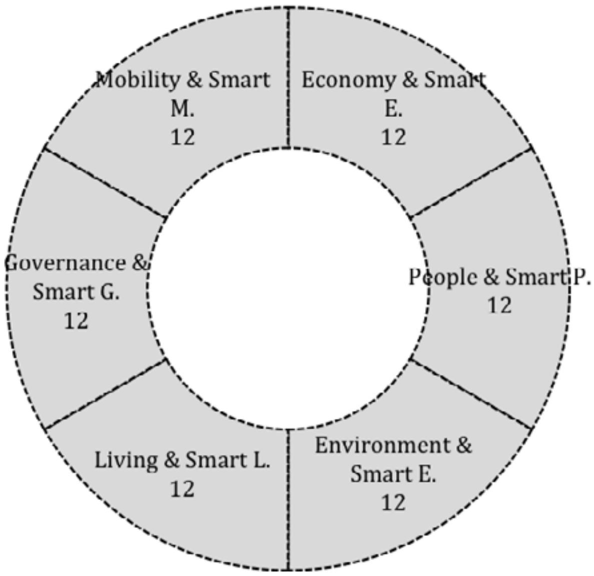
- New categories (e.g. legality)
- Presence of standars + smart indicators
- Presence of several editions
- Extended set of indicators divided into several groups

■ Presence of KPIs
☐ Presence of step-by-step approach
☐ Presence of scenarios

Authors and scope

The ranking is developed by Forum PA with the aim of study and map italian state of smartness.

Indicators distribution graph



Weak points

The main weak points are, in opinion of this reasearch, the following:
- each sector is analysed but many indicators are missing, e.g. inside the environment sector many KPIs are not included (such as building state of maintenance, performances, etc)
- indicators are quite general in each sector, they don't describe a city or a portion of city in a holistic way

Main sources: http://www.icitylab.it/il-rapporto-icityrate/cose/

Key performance indicators

Theme	Sub-theme	Indicators
Economy	Productivity	Valore aggiunto pro capite(in migliaia di euro)
	Entrepreneurship	Imprese attive per 100 abitanti
	Work qualification	Quota % occupati con titolo di studio laurea o superiore
	Leadership	Imprese con 250 addetti o più per 10.000 imprese
	Credit availability	Rapporto impieghi/depositi
	Productive internationali-zation	Valore delle esportazioni per abitante in euro
Smart Economy	Productive innovation	Innovazione sistema produttivo (addetti e spesa RSedelle imprese, occupati settori ad alta tecnologia e conoscenza, imprese che hanno introdotto innovazioni)
	Research and development related jobs	Addetti R&S imprese, istituzioni e ist. no profit per 10.000 residenti
	Innovation	Brevetti depositati per 10.000 unità di forze lavoro
	Internet connections diffusion	Imprese attive nei settori legati a internet per 10.000 imprese
	Start up	Imprese start up innovative e contratti di rete per 10.000 imprese
	International relations	Pernottamenti visitatori stranieri per motivi di lavoro (esclusi frontalieri) per 100 abitanti
Living	Sanitary assistance	Emigrazione ospedaliera in altra regione per ricoveri ordinari acuti sul totale delle persone ospedalizzate residenti nella regione (percentuale)
	School dispersion	Dispersione al termine del quinquennio 2009-10/2013-14 nelle province
	Children healthcare	Indice presa in carico asili nido
	Elder healthcare	Anziani trattati in assistenza domiciliare integrata (ADI) rispetto al totale della popolazione anziana (65 anni e oltre) (percentuale)
	Job opportunities	Tasso % mancata partecipazione al lavoro
	Social cohesion	Quota % famiglie in condizione di povertà relativa
Smart Living	Broadband	Quota % di popolazione potenzialmente coperta dalle infrastrutture a banda larga (30 Mbps)
	Residential broadband	Velocità media in download (Mb/s) per le utenze consumer ADSL
	Sharing Economy	Percentuale di servizi di coworking, banche del tempo e Gas su totale rilevati in Italia
	Gender unions	Quota di Comuni che riconoscno le unioni civili all'interno della provincia sul totale dei comuni che ricoscono le unioni civili in Italia
	Leasure opportunities	Addetti unità locali attività artistiche, sportive e intrattenimento (escluo gioco) per 1.000 abitanti di 6 anni e più
	International culture	Valore delle esportazioni di prodotti delle attività artistiche, creative e di intrattenimento per abitante in euro
Environment	Air quality	Numero di giorni di superamento del limite per la protezione della salute umana previsto per il PM10
	Recycling rate	Quota di raccolta differenziata
	Water purification	Indice (0-100) Legambiente basato su quota abitanti allacciati, giorni funzionamento, abbattimento COD
	Energy consumption	kWh per abitante di consumo energia elettrica per uso domestico
	Green surface availability	Mq verde urbano per abitante
	Green industries	Quota % imprese dell'industria e servizi con dipendenti che investono nel green
Smart environ-ment	Air quality control	Centraline fisse di monitoraggio della qualità dell'aria per 100.000 abitanti
	Waste delivery initiatives	Quota % servizi o attività presenti su 8 possibili
	Water network leakage	% Acqua immessa non erogata
	Public Pv installations	Potenza dei pannelli solari fotovoltaici installati sugli edifici di proprietà dell'amministrazione (kW per 1.000 abitanti)
	Green surfaces rate	Incidenza % sulla superficie comunale delle aree di verde urbano e naturali protette
	Eco-management	Indice (0-100) basato su comportamenti dell'amministrazione

Mobility	Air accessiblity	Indice (Italia=100) di dotazione infrastrutturale (aeroporti e bacini di utenza) dell'Ist. Tagliacarne
	Ground accessibility	Media Indici (Italia=100) di dotazione infrastrutturale (rete stradale e ferrovaria) dell'Ist. Tagliacarne
	Territorial fluidity	Quota % occupati che impiegano fino a 30 minuti per raggiungere il posto di lavoro
	Public transport offer	Migliaia posti-km offerti da mezzi TPL (autobus, filobus, tram, metropolitana) per abitante
	Intermodality	Stalli nei parcheggi di scambio con il trasporto pubblico per 1000 autovetture
	Accident rate	Tasso di incidenti stradali per comune capoluogo di provincia (per 100.000 abitanti)
Smart mobility	Sustainable mobility	Quota % servizi o attività presenti su 3 possibili
	Alternative mobility	Percentuale di spostamenti privati motorizzati (auto e moto) sul totale degli spostamenti
	Traffic limitations	Kmq di ZTL per 100 Kmq di superficie
	Cycling	Km piste ciclabili per 100 kmq superficie
	Ecological cars adjustments	Quota % euro 4 o superiore su autovetture circolanti
	Sharing mobility	Passeggeri TPL annui per abitante
People	Education level	Quota % popolazione residente di 20 anni e più con titolo di studio universitario
	Social participation	Rapporto % volontari nell'attività non profit su totale residenti
	Job research fluidity	% Persone attivamente in cerca di lavoro su somma persone in cerca di lavoro e forze lavoro potenziali
	Festivals participation rate	Ingressi a spettacoli per 100 residenti
	Cultural open-mindness	Quota % stranieri stranieri su totale laureati residenti
	Works gender balance	Rapporto tra tassi di occupazione 15-64 femmine e maschi
Smart people	Connected families (broa-dband)	Quota % delle famiglie con connessione a internet
	Internet usage rate	Quota % delle persone dai 6 anni in su che utilizzano internet almeno una volta la settimana
	Attractivity	Attrazioni (cultura, spettacolo, intrattenimeno, shopping) citate da Trip advisor per 10.000 residenti nel territorio provinciale
	Home banking diffusion	Clienti servizi home e corporate banking alle famiglie ogni 100 residenti
	Schools' informatization	PC per 100 alunni
	Non profit association present on social networks	Quota % delle istituzioni non profit presenti sui social network
Governance	Electoral participation	% Votanti elezioni europee 2014
	Governance confidence	Voto medio di fiducia (0-10) alle istituzioni locali
	Economic stability	Media aritmetica degli indici di autonomia finanziaria, equilibrio parte corrente, flessibilità potenziale della spesa
	Management capacity	Media aritmetica degli indici di bontà previsione della spesa, velocità gestione spese correnti, capacità riscossione entrate proprie
	Associations participation	Numero adesioni ad associazioni e reti di amministrazioni
	Gender balance	Quota % sindaci in carica donne sul totale
Smart gover-nance	Open dataset	Numerosità dei dataset liberati da regione, provincia e comune
	Open websites	Indice basato sulla rilevazione delle caratteristiche rispettate dai siti di comune, provincia e camera di commercio
	Comunications	Quota % canali di comunicazione attivati dall'amministrazione comunale su 11 possibili
	Twitter followers	Followers per 100 residenti
	Social reporting	Quota % forme di rendicontazione sociale attivate dall'amministrazione comuna-le su 5 possibili
	Environmental planning	Quota % strumenti di pianificazione ambientale utilizzati su 5 considerati

Legality	Crime	Delitti legati alla microcriminalità nelle città (numero per mille abitanti)
	Tax evasion / black workers	Percentuale di unità di lavoro in nero sul totale delle unità di lavoro
	Threatened administrators	Percentuale di amministratori minacciati sul totale dell'anno
	Threatened journalists	Percentuale di giornalisti minacciati sul totale dell'anno
	Concrete cycle	Percentuale di infrazioni accertate sul totale dell'anno nel ciclo del cemento
	Waste management	Percentuale di infrazioni accertate sul totale dell'anno nel ciclo dei rifiuti
Smart legality	Courts efficiency	Percentuale di procedimenti civili pendenti ultra triennali sul totale
	Industries legality rating	Imprese con sede legale nel comune che hanno chiesto e ottenuto il rating di legalità su 10.000 imprese
	Procurement	Percentuale di bandi con criterio di assegnazione "massimo ribasso"
	Relocated confiscated goods	Percentuale di beni confiscati ricollocati
	Mafia involved municipalities	Numero di Comuni sciolti per mafia dal 1991 ad oggi
	Eco-crimes	Percentuale di ecoreati sul totale delle infrazioni dell'anno

WORKSHEET - KPI MODEL	n°03

SMART CITY INDEX

Model main data

☐ Ex ante model
■ Ex post model

■ Ranking instrument
☐ Application for certifications / labels / awards
☐ Rating instrument
☐ Thesis
☐ EU H2020 project
☐ Tool

Innovative aspects and strenghts

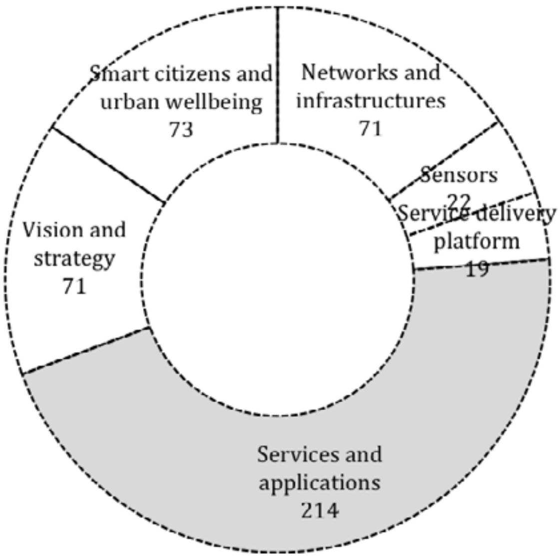
- Italian based
- Conceived as a PA instrument
- Aim of finding best practises
- Aim of defining a common metric
- Simple reading of results through the use of spider graphs

■ Presence of KPIs
☐ Presence of step-by-step approach
☐ Presence of scenarios

Authors and scope

The ranking is developed in the first editions by Between and then by EY, for the Italian Digital Agency, with the aim of identify best practises with a shared metric. It is based on the Italian country and it maps the main municipalities, which are provincial or regional capital. With a total of 470 indicators, the ranking evaluate, also, all cities PAES (Action plans for sustainable energy), considering the city as the superposition of layers.

Indicators distribution graph



Weak points

The main weak points are, in opinion of this reasearch, the following:
- at first indicators are inhomogeneous in respect to selected themes and subthemes with a predominance of services and applications analysis
- environment, built environment and resource related themes are less developed in respect to ICT and services

Main sources: http://www.ey.com/it/it/newsroom/news-releases/cs-2016-italia-smart

Key performance indicators[1]

Theme	Sub-theme	Indicators
Networks and infra-structures (71 KPIs)	Telecommunications	Broadband; networks and nets for safety; schools' infrastructure
	Transport and mobility	Public mobility; Electric and cycling mobility; Shared mobility; Personal / Private mobility
	Energy	District heating; renewables; public lighting; smart grid
	Environment	Water network; Sewerage; Waste cycle
Sensors (22 KPIs)	Streets networks	ZTL access; parking occupation; traffic detectors; smart traffic lights; autodetectors
	Public transport	Presence of sensors on buses and taxi
	Electric network monitoring	Presence of smart public lights
	Comfort control	N° of control units in respect to urban dimension
	Building security	Seismic monitoring
	Public areas video surveillance	Presence
Service delivery platform (19 KPIs)	Readiness	Citizen app store; cards diffusion; presence of unit controls for transports and security; diffusion of electronic payments; advanced systems for online citizens identification; presence of open data and datasets
	Integration, interoperability and dematerialisation	Digital documents; multi-channel services; integration of services
Services and applica-tions (214 KPIs)	Government	online anagraphic services; electronic payments; social network integration; building / construction procedures
	School	ICT for education; administrative ICT services
	Mobility	e-tickets; multimodal public mobility planning; electronic payments; sha-ring and pooling mobility; end-users information system
	Tourism and culture	Web-based information; online booking; card/app presence; digital libraries; e-commerce and social network based culture
	Healthcare	ICT and web-based services for end-users; electronic health record
Vision and strategy (71 KPIs)	Strategic Smart City planning and vision	Presence of strategic plans
	Action plan for sustainable energy	Presence
	Policies and building incen-tives	Presence
	Economic and financial capacity	-
	Participation, comunication and transparency	-
Smart citizens and urban wellbeing (73 KPIs)	Smart citizens	Electric mobility, car charing demand; gas, energy, water consumption; building retrofitting; cultural services fruition; school and digital literacy
	Urban wellbeing	Mobility quality; public gardens availability; acoustic and air pollution; cultural services availability; healthcare and social services; personal, environmental safety

1 Please note that due to the total amount of KPIs (470) the table maps themes, subthemes and major groups of indicators, as described inside the ranking main report.

WORKSHEET - KPI MODEL	n°04

GREEN CITY INDEX

Model main data

☐ Ex ante model
■ Ex post model

■ Ranking instrument
☐ Application for certifications / labels / awards
☐ Rating instrument
☐ Thesis
☐ EU H2020 project
☐ Tool

Innovative aspects and strenghts

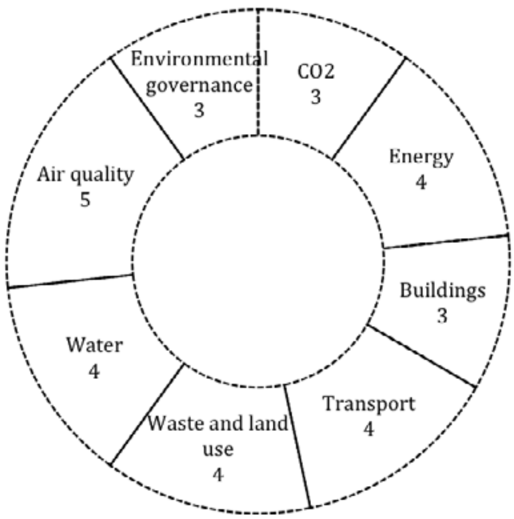
- one of the most used index worlwide, as a consequence they have mapped a wide panel of cities in the world
- aim of defining best practise
- aim of defining a common understanding and metrics about green cities

■ Presence of KPIs
☐ Presence of step-by-step approach
☐ Presence of scenarios

Authors and scope

The ranking is developed by the Economist Intelligence Unit, sponsored by Siemens, with the aim of define a common understanding and metric about green cities. Their objective of anlysing best practises it is pursued through the use of the index worldwide.

Indicators distribution graph



Weak points

The main weak points are, in opinion of this reasearch, the following:
- the decision of having a small set of indicators, even if it simplify a lot the analysis of cases and can be used for a speditive or preliminary analysis, necessary, gives back lot of information
- indicators seems to be not directly related to specific urban context, in fact the aim of the index is mainly to analyse the current situation on worldwide/country level (without specificities on urban specificities). As a consequene the index remains a bit too general

Main sources: https://www.siemens.com/entry/cc/features/greencityindex_international/all/en/pdf/gci_report_summary.pdf

Key performance indicators

Theme	Indicators
CO_2	CO_2 intensity
	CO_2 emissions
	CO_2 reduction strategy
Energy	Energy consumption
	Energy intensity
	Renewable energy consumption
	Clean and efficient energy policies
Buildings	Energy consumption of residential buildings
	Energy-efficient buildings standards
	Energy-efficient buildings initiatives
Transport	Use of non-car transport
	Size of non-car transport network
	Green transport promotion
	Congestion reduction policies
Waste & land use	Municipal waste production
	Waste recycling
	Waste reduction policies
	Green land use policies
Water	Water consumption
	System leakages
	Wastewater system treatment
	Water efficiency and treatment policies
Air quality	Nitrogen dioxide
	Sulphur dioxide
	Ozone
	Particulate matter
	Clean air policies
Environmental governance	Green action plan
	Green management
	Public participation in green policy

WORKSHEET - KPI MODEL	**n°05**

GBC FOR NEIGHBOURHOOD (LEED)

Model main data

☐ Ex ante model
■ Ex post model

☐ Ranking instrument
☐ Application for certifications / labels / awards
■ Rating instrument
☐ Thesis
☐ EU H2020 project
☐ Tool

Innovative aspects and strenghts

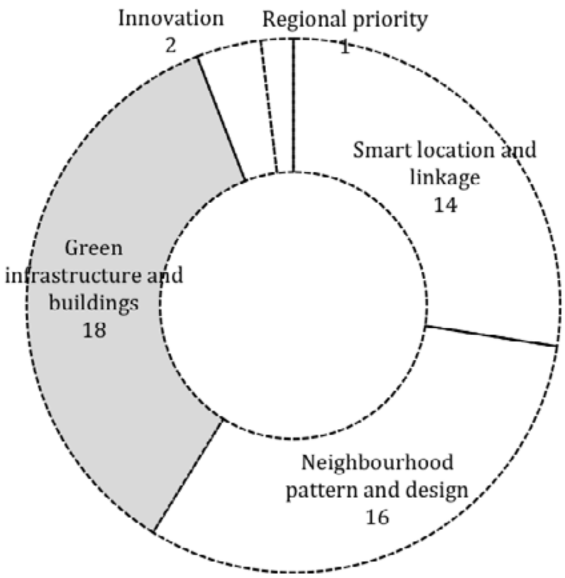
- Focus on specific urban dimensione
- Presence of several levels of analysis
- Deep analysis on buildings
- Even if it is an ex post model it gives insights on how to built new districts or to adapt existing ones

■ Presence of KPIs
☐ Presence of step-by-step approach
☐ Presence of scenarios

Authors and scope

This rating instrument aims (both on the italian and english version) to analyse neighbourhoods, with a focus on environment. It is developed by LEED (and GBC in Italy). As happens for several rating systems, the developed protocol include not only indicators of performance but also prerequisite, which are considered as interesting as indicators and, as a consequence, included into next page table.

Indicators distribution graph



Weak points

The main weak points are, in opinion of this reasearch, the following:
- absence of indicators about pollution; participation and end-users
- absence of indicators about digital and ICT implementation
- absence of indicators about monitoring and sensors
- absence of relation with the rest of the city

Main sources: http://www.gbcitalia.org/page/show/gbc-quartieri?locale=it

Key performance indicators

Theme	Sub-theme	Indicators / Points
Smart location and linkage	Smart Location (pre-requisite)	Infill site; Adjacent Sites with Connectivity; Transit Corridor; Sites with Near-by Neighborhood Assets
	Imperiled species and ecological communities conservation	Habitat Conservation Plan;
	Wetland and water body conservation (pre-requisite)	N° Development on Wetlands and Water Bodies; Rainwater Management and Protected Buffers
	Agricultural land conservation (pre-requisite)	Infill Sites; Sites Served by Transit; Development Rights Receiving Area; mitigation measures for Sites with Affected Soils
	Floodplain avoidance (pre-requ	American Society of Civil Engineers Standard; National Flood Insurance Program
	Preferred location	Location Type; Connectivity; Designated High-Priority Locations;
	Brownfield remediation	Brownfield Site; High-Priority Redevelopment Area;
	Access to quality transit	Minimum daily transit service for projects with multiple transit types; with commuter rail or ferry service only
	Bicycle facilities	Bikable Location; Bicycle Network;
	Housing and job proximity	Project with Affordable Residential Component; Project with Residential Component; Infill Project with Nonresidential Component
	Steep slope protection	Required restoration and protection areas of slope
	Site design for habitat or wetland and water body conservation	
	Restoration of habitat or wetland and water bodies	
	Long term conservation management of habitat or wetlands and water bodies	
Neighbourhood pattern and design	Walkable streets	
	Compact development	
	Connected and open community	Surrounding Connectivity; Internal Connectivity
	Mixed-use neighbourhoods	uses within 1/4-mile (400-meter) walking distance, by percentage of occupancy
	Housing types and affordability	Diversity of Housing Types; Affordable Housing
	Reduced parking footprint	
	Connected and open community	
	Transit facilities	
	Transportation demand management	Transit Passes; Developer-Sponsored Transit; Vehicle Sharing; Unbundling of Parking and Parking Fees; Guaranteed Ride Home Program; Flexible Work Arrangements
	Access to civic and public space	
	Access to recreation facilities	
	Visitability and universal design	Universal Design Features Throughout the Home; Kitchen Features; Bedroom and Bathroom Features;
	Community outreach and involvement	Community Outreach; Charrette; Endorsement Program
	Local food production	Neighborhood Gardens; Community-Supported Agriculture; Proximity to Farmers Market
	Tree-lined and streetscapes	Tree-Lined Blocks; Shaded Sidewalks;
	Neighbourhood schools	

Green infrastructure and buildings	Certified green buildings (pre-requisite)	
	Minimum building energy performance (pre-requisite)	Whole-Building Energy Simulation; Prescriptive Compliance
	Indoor water use reduction	
	Construction activity pollution prevention	
	Outdoor water use reduction	No Irrigation Required; Reduced Irrigation
	Building reuse	
	Historic resource preservation and adaptative reuse	
	Minimized site disturbance	
	Rainwater management	retaining rainwater on site
	Heat island reduction	High-Reflectance and Vegetated Roofs;
	Solar orientation	Block Orientation; Building Orientation
	Renewable energy production	
	District heating and cooling	
	Infrastructure energy efficiency	
	Wastewater management	reusing wastewater
	Recycled and reused infrastructure	
	Solid waste management	
	Light pollution reduction	Exterior Lighting for Residential Areas; Exterior Lighting for Circulation Network; Exterior Lighting for All Other Areas
Innovation	Innovation	Innovation; Pilot; additional strategies; exemplary performances
	LEED Accredited Professional	
Regional priority	Regional priority	

WORKSHEET - KPI MODEL	**n°06**

BREEAM FOR COMMUNITIES

Model main data

☐ Ex ante model
■ Ex post model

☐ Ranking instrument
☐ Application for certifications / labels / awards
■ Rating instrument
☐ Thesis
☐ EU H2020 project
☐ Tool

Innovative aspects and strenghts

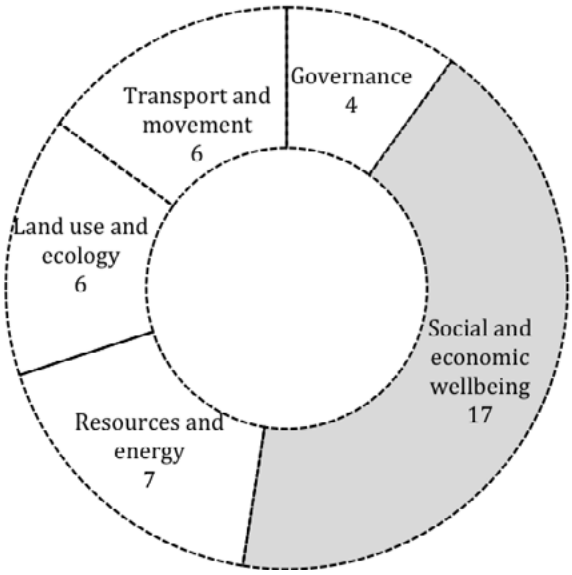
- 3 steps compose the approach of addressing the desi-gn phase of new neighbourhoods
- presence of varied themes of analysis

■ Presence of KPIs
■ Presence of step-by-step approach
☐ Presence of scenarios

Authors and scope

This rating instrument aims to address the design phase of built environment at the early stages of the process, by addressing “key environmental, social and economic sustainability objectives that have an impact on large-scale development projects”. It covers the assessment and certification of the designs and plans for new development and regeneration projects at the neighbourhood scale or larger.

Indicators distribution graph



Weak points

The main weak points are, in opinion of this reasearch, the following:
- based on new neighbourhood and urban development rather than on adaptation of existing ones.

Main sources: http://www.breeam.com/communities

Key performance indicators

Theme	Indicators / Points
Governance	Consultation plan
	Consultation and engagement
	Design review
	Community management of facilities
Social and economic wellbeing	Economic impact
	Demographic needs and priorities
	Flood Risk Assessment
	Noise pollution
	Housing provision
	Delivery of services, facilities and amenities
	Public realm
	Microclimate
	Utilities
	Adapting to climate change
	Green infrastructure
	Local parking
	Flood risk management
	Local vernacular
	Inclusive design
	Light pollution
	Training and skills
Resources and energy	Energy strategy
	Existing buildings and infrastructure
	Water strategy
	Sustainable buildings
	Low impact materials
	Resource efficiency
	Transport carbon emissions
Land use and ecology	Ecology strategy
	Land use
	Water pollution
	Enhancement of ecological value
	Landscape
	Rainwater harvesting
Transport and movement	Transport assessment
	Safe and appealing streets
	Cycling network
	Access to public transport
	Cycling facilities
	Public transport facilities

WORKSHEET - KPI MODEL	**n°07**

CASBEE FOR CITIES

Model main data

☐ Ex ante model
■ Ex post model

☐ Ranking instrument
☐ Application for certifications / labels / awards
■ Rating instrument
☐ Thesis
☐ EU H2020 project
☐ Tool

Innovative aspects and strenghts

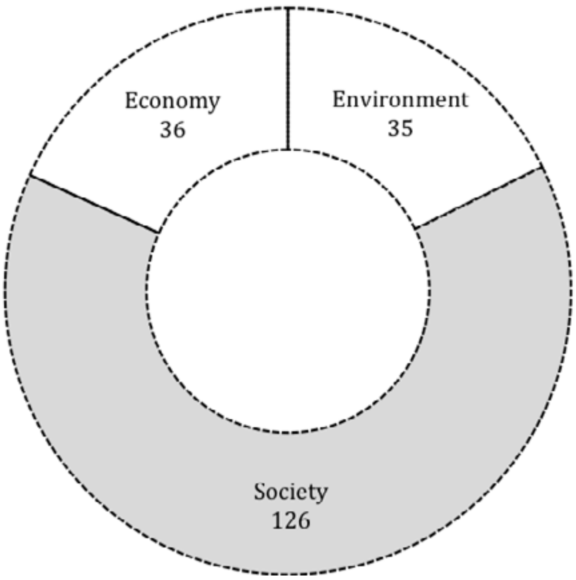
- Scenario calculation based on a mathematic formula
- Analysis at city level
- Analysis of both urban quality and environmental load of a municipality

■ Presence of KPIs
☐ Presence of step-by-step approach
■ Presence of scenarios

Authors and scope

CASBEE for cities is developed by CASBEE Japan with the aim of evaluating the environmental performances of a city. It is based on KPIs and scenario evaluation through the use of a equation between urban quality and environmental load.

Indicators distribution graph



Weak points

The main weak points are, in opinion of this reasearch, the following:
- indicators are not clearly divided
- indicators are not clearly related with regeneration of urban space, but are more conceived as an image of the state of the art

Main sources: http://www.ibec.or.jp/CASBEE/english/overviewE.htm

Key performance indicators

Themes	Indicators / Points
Environment	Mean urban air pollution of particulate matter (PM10 and PM 2.5) Area of public and green space as a proportion of total city space Percentage of urban solid waste regularly collected and well managed Fine particulate matter concentration (PM 2.5) Particulate matter concentration (PM10) NO_2 concentration SO_2 concentration O_3 concentration Noise pollution Percentage of city population with regular solid waste collection Total collected municipal solid waste per capita Percentage of the city's solid waste that is recycled Percentage of the city's solid waste that is disposed of in a sanitary landfil Percentage of the city's solid waste that is disposed of in an incinerator Percentage of the city's solid waste that is burned openly Percentage of the city's solid waste that is disposed of in an open dump Percentage of the city's solid waste that is disposed of by other means Hazardous Waste Generation per capita (tonnes) Percentage of the city's hazardous waste that is recycled Green are (hectares) per 100,000 population Annual number of trees planted per 100,000 population Disclosure of Natural Resource Rights Holdings Global Food Loss Indicator Consumption of ozone-depleting substances (MDG Indicator) Aerosol optical depth (AOD) Share of companies valued at more than [$1 billion] that publish integrated monitoring] Number of businesses per 100,000 population Share of coastal and marine areas that are protected Percentage of fish tonnage landed within Maximum Sustainable Yield (MSY) Annual change in forest area and land under cultivation (modified MDG Indicator) Area of forest under sustainable forest management as a percent of forest area Annual change in degraded or desertified arable land (% or ha) Red List Index Protected areas overlay with biodiversity Percentage change in number of native species
Society	Percentage of urban population living in slums or informal settlements (MDG Indicator) Percentage of people within 0.5km of public transit running at least every 20 minutes Ratio of land consumption rate to population growth rate, at comparable scale Losses from natural disasters, by climate and non-climate-related events (in US$ and lives lost) Number of fire related deaths per 100,000 population Number of natural disaster related deaths per 100,000 population Square meters of public indoor recreation space per capita Square meters of public outdoor recreation space per capita Number of police officers per 100,000 population Number of homicides per 100,000 population Crimes against property per 100,000 population Response time for police department from initial call Percentage of city population living in slums Number of homeless per 100,000 population Percentage of households that exist without registered legal titles Areal size of informal settlements as a percentage of city area Proportion of population below minimum level of dietary energy consumption (MDG Indicator) Percentage of women of reproductive age (15-49) with anemia Prevalence of stunting and wasting in children under 5 years of age Percentage of children less than six months old who are fed breast milk alone (no other liquids or food) Percentage of women, 15-49 years of age, who consume at least 5 out of 10 defined food groups Crop yield gap (actual yield as % of attainable yield) Number of agricultural extension workers per 1000 farmers [or share of farmers covered by agricultural extension programs and services Nitrogen use efficiency in food systems Crop water productivity (tons of harvested product per unit irrigation water) Maternal mortality ratio (MDG Indicator) and rate Neonatal, infant, and under-5 mortality rates (modified MDG Indicator) Percent of children receiving full immunization (as recommended by national vaccination schedules) HIV incidence, treatment rate, and mortality (modified MDG Indicator) Incidence, prevalence, and death rates associated with all forms of TB (MDG Indicator) Incidence and death rates associated with malaria (MDG Indicator) Probability of dying between exact ages 30 and 70 from any of cardiovascular disease, cancer, diabetes, chronic respiratory disease, [or suicide] Percent of population overweight and obese, including children under 5

Society	Road traffic deaths per 100,000 population Consultations with a licensed provider in a health facility or the community per person, per year Percentage of population without effective financial protection for health care Proportion of persons with a severe mental disorder (psychosis, bipolar affective disorder, or moderate-severe depression) who are using services Contraceptive prevalence rate (MDG Indicator) Current use of any tobacco product (age-standardized rate) Average life expectancy Number of in-patient hospitals per 100,000 population Number of physicians per 100,000 population Under age five mortality per 1,000 live births Number of nursing and midwifery personnel per 100,000 population Number of mental health practitioners per 100,000 population Suicide rate per 100,000 population Transportation fatalities per 100,000 population Percentage of children (36-59 months) receiving at least one year of a quality pre-primary education program Early Child Development Index (ECDI) Primary completion rates for girls and boys Percentage of girls and boys who master a broad range of foundational skills, including in literacy and mathematics by the end of the primary school cycle (based on credibly established national benchmarks) Secondary completion rates for girls and boys Percentage of girls and boys who achieve proficiency across a broad range of learning outcomes, including in literacy and in mathematics by end of lower secondary schooling cycle (based on credibly established national benchmarks) Tertiary enrollment rates for women and men Percentage of students completing primary education : survival rate Percentage of students completing secondary education : survival rate Primary education student / teacher ratio Percentage of male school-aged population enrolled in schools Percentage of school-aged population enrolled in schools Number of higher education degrees per 100,000 population Prevalence of girls and women 15-49 who have experienced physical or sexual violence [by an intimate partner] in the last 12 months Percentage of referred cases of sexual and gender-based violence against women and children that are investigated and sentenced Percentage of women aged 20-24 who were married or in a union before age 18 Percentage of girls and women aged 15-49 years who have undergone FGM/C Average number of hours spent on paid and unpaid work combined (total work burden), by sex Percentage of seats held by women and minorities in national parliament and/or sub-national elected office according to their respective share of the population (modified MDG Indicator) Met demand for family planning (modified MDG Indicator) Percentage of female school-aged population enrolled in schools Women as a percentage of total elected to city-level office Percentage of women employed in the city government workforce Percentage of population using safely managed water services, by urban/rural (modified MDG Indicator) Percentage of population using safely managed sanitation services, by urban/rural (modified MDG Indicator) Percentage of wastewater flows treated to national standards [and reused] Indicator on water resource management Proportion of total water resources used (MDG Indicator) Percentage of city population served by wastewater collection Percentage of the city's wastewater that has received no treatment Percentage of the city's wastewater receiving primary treatment Percentage of the city's wastewater receiving secondary treatment Percentage of the city's wastewater receiving tertiary treatment Q2.81 Percentage of city population with potable water supply service Percentage of city population with sustainable access to an improved water source Percentage of population with access to improved sanitation Total domestic water consumption per capita (litres / day) Total water consumption per capita (litres / day Average annual hours of water service interruption per household Percentage of water loss (unaccounted for water) Access to all-weather road (% access within [x] km distance to road) Mobile broadband subscriptions per 100 inhabitants, by urban/rural Index on ICT maturity Manufacturing value added (MVA) as percent of GDP Total energy and industry-related GHG emissions by gas and sector, expressed as production and demand-based emissions (tCO2e) Personnel in R&D (per million inhabitants) Average number of electrical interruptions per customer per year Average length of electrical interruptions (in hours) Number of firefighters per 100,000 population Number of volunteer and part-time firefighters per 100,000 population Response time for emergency response services from initial call Response time for fire department from initial call

Society	Number of internet connections per 100,000 population Number of cell phone connections per 100,000 population Number of landline phone connections per 100,000 population Kilometres of high capacity public transport system per 100,000 population Kilometres of light passenger public transport system per 100,000 population Annual number of public transport trips per capita Number of personal automobiles per capita Percentage of commuters using a travel mode to work other than a personal vehicle Number of two-wheel motorized vehicles per capita Kilometres of bicycle paths and lanes per 100,000 population Commercial air connectivity (number of non-stop commercial air destinations Violent injuries and deaths per 100,000 population Number of refugees Proportion of legal persons and arrangements for which beneficial ownership information is publicly available Revenues, expenditures, and financing of all central government entities are presented on a gross basis in public budget documentation and authorized by the legislature Percentage of children under age 5 whose birth is registered with a civil authority Existence and implementation of a national law and/or constitutional guarantee on the right to information Perception of public sector corruption Debt service ratio (debt service expenditure as a percentage of a municipality's own-source revenue) Capital spending as a percentage of total expenditure Own-source revenue as a percentage of total revenues Tax collected as a percentage of tax billed Voter participation in last municipal election (as a percentage of eligible voters) Number of convictions for corruption and / or bribery by city officials per 100,000 population Citizens' representation : number of local officials elected to office per 100,000 population Number of registered voters as a percentage of the voting age population Violent crime rate per 100,000 population
Economy	Domestic revenues allocated to sustainable development as percent of GNI - by sector Assessed value of commercial and industrial properties as a percentage of total assessed value of all properties Proportion of population below $1.25 (PPP) per day (MDG Indicator) Proportion of population living below national poverty line, by urban/rural (modified MDG Indicator) Multidimensional Poverty Index Percentage of eligible population covered by national social protection programs Percentage of women, men, indigenous peoples, and local communities with secure rights to land, property, and natural resources, measured by: (i) percentage with documented or recognized evidence of tenure, and (ii) percentage who perceive their rights are recognized and protected Losses from natural disasters, by climate and non-climate-related events (in US$ and lives lost) Total fertility rate Percentage of city population living in poverty Share of the population using modern cooking solutions, by urban/rural Share of the population using reliable electricity, by urban/rural Implicit incentives for low-carbon energy in the electricity sector (measured as US$/MWh or US$ per ton avoided $CO2$) Rate of primary energy intensity improvement Total residential electrical energy use per capita (kWh / year) Percentage of city population with authorized electrical service Energy consumption of public buildings per year (kWh / m2) The percentage of total energy derived from renewable sources, as a share of the city's total energy consumption Total electrical energy use per capita (kWh / year) GNI per capita (PPP, current US$ Atlas method) Country implements and reports on System of Environmental-Economic Accounting (SEEA) accounts Youth employment rate, by formal and informal sector Ratification and implementation of fundamental ILO labor standards and compliance in law and practice City's unemployment rate Percentage of persons in full-time employment Youth unemployment rate Jobs / housing ratio Indicator on inequality at top end of income distribution: GNI share of richest 10% or Palma ratio Percentage of households with incomes below 50% of median income ("relative poverty") Domestic revenues allocated to sustainable development as percent of GNI, by sector Official development assistance and net private grants as percent of GNI Private net flows for sustainable development at market rates as share of high-income country GNI, by sector Annual report by Bank for International Settlements (BIS), International Accounting Standards Board (IASB), International Financial Reporting Standards (IFRS), International Monetary Fund (IMF), World Intellectual-Property Organization (WIPO), and World Trade Organization (WTO) [other organizations to be added] on the relationship between international rules and the SDGs and the implementation of relevant SDG targets Share of SDG Indicators that are reported annually Evaluative Wellbeing and Positive Mood Affect Number of new patents per 100,000 population per year

WORKSHEET - KPI MODEL	**n°08**

PLEEC - PLANNING FOR ENERGY EFFICIENT CITIES

Model main data

☐ Ex ante model
■ Ex post model

☐ Ranking instrument
☐ Application for certifications / labels / awards
☐ Rating instrument
☐ Thesis
■ EU H2020 project
☐ Tool

Innovative aspects and strenghts

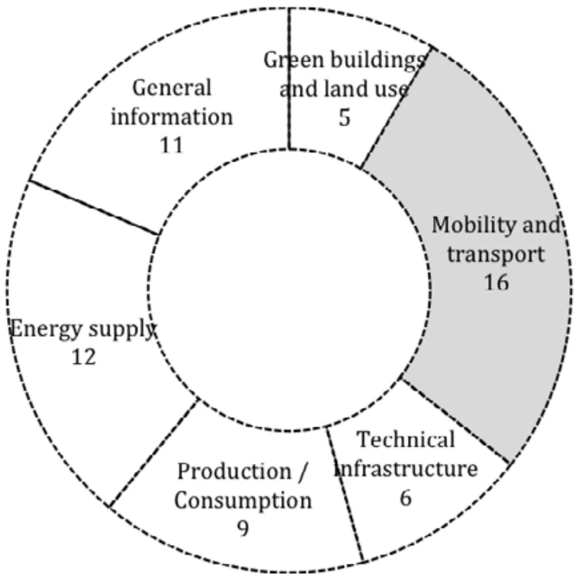
- Big focus on energy and on balance between fossil fuel and renewable energy analysis

■ Presence of KPIs
☐ Presence of step-by-step approach
☐ Presence of scenarios

Authors and scope

PLEEC project is developed under the European work programme Horizon 2020 and it aims at finding solution for boosting energy efficiency in Europe. One of their main objective is to propose a set of indicators, whit which monitoring or urban performance can be done. Part of the indicators' selection is result of surveys made on European cities and stakeholders.

Indicators distribution graph



Weak points

The main weak points are, in opinion of this reasearch, the following:
- indicators are un-balanced in respect to selected themes and subthemes
- the energy sector (composed by production / consumption + energy supply) is investigated a lot (21/59) as well as mobility and trasport
- the built environment and land use is under developed in respect to other sectors

Main sources: http://www.pleecproject.eu/

Key performance indicators

Theme	Sub-theme	Indicators / Points
Green buildings and land use	Renovation	Share of annual thermal renovation
	Building technologies	Share of dwelling in low (zero) energy buildings Share of public low (zero) energy buildings
	Spatial structure and land use	Population density Share of detached house
Mobility and transport	Public transport	Transport performance in public transport Energy demand in public transport CO_2 emissions in public transport Cost of a monthly ticket for public transport
	Motorised private transport	Tranport performance in motorised private transport Energy demand in motorised private transport CO_2 emissions in motorised private transport Cost of petrol Parking fee Level of motorisation
	Pedestrian transport and cycling	Transport performance in bicycle transport Transport performance in pedestrian transport Lenght of bicycle network per inhabitant
	Transport of goods	Tranport performance in trasport of goods (freight) Energy demand in trasport of goods (freight) CO_2 emissions in trasport of goods (freight)
Technical infrastructure	Waste, water and sewage management	Waste generation Recycling of waste Waste collection fee
	Electric prower grids	Share of smart meters
	District heating / cooling grids	Share of district heating
	Public lighting	Share of energy efficient lamp
Production / Consumption	Industry and commerce	Energy demand in industry CO_2 emissions in industry Share of companies with energy management
	Public and private services	Energy demand in service sector CO_2 emissions in service sector
	Consumers / private households	Energy demand in private households CO_2 emissions in private households Share of household income spent on petrol Share of household income spent on electricity
Energy supply	Fossil / nuclear	Energy supply - solid fuels Energy supply - gas Energy supply - crude oil and petroleum products Energy supply - nuclear Electricity tarif - traditionel mix
	Renewables	Energy supply - wind Energy supply - biomass Energy supply - hydropower Energy supply - tide, wave, ocean Energy supply - geothermal including heat pump Energy supply - waste Electricity tarif - renewable mix
General information	GDP Number of inhabitants Settled area Number of households Number of dwellings Number of residential building Average annual households net income Import dependency Export dependency Primary energy consumption Final energy consumption	

WORKSHEET - KPI MODEL	**n°09**

CITY KEYS

Model main data

☐ Ex ante model
■ Ex post model

☐ Ranking instrument
☐ Application for certifications / labels / awards
☐ Rating instrument
☐ Thesis
■ EU H2020 project
☐ Tool

Innovative aspects and strenghts

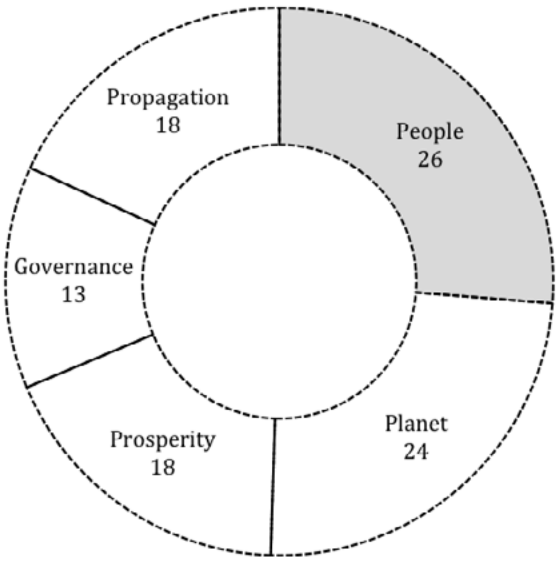
- Well balanced and complete set of indicators
- Presence of indicators for replication and scalability
- Presence of indicators about green economy and participation
- Indicators about success and innovation

■ Presence of KPIs
☐ Presence of step-by-step approach
☐ Presence of scenarios

Authors and scope

CityKeys project is developed under the European work programme Horizon 2020 and it aims at being a horizontal project to the Smart City and Community call. Its aim is, as a consequence, to support lighthouse cities of SCC1 call in tracking progress about SC implementation. The main objective of CityKeys is, in fact, to define a set of indicators.

Indicators distribution graph



Weak points

The main weak points are, in opinion of this reasearch, the following:
- presence of under developed indicators about built environment and mobility
- absence of indicators about piloting solutions on portions of the city

Main sources: http://www.citykeys-project.eu/

Key performance indicators

Theme	Sub-theme	Indicators / Points
People	Health	Improved access to basic health care services Encouraging a healthy lifestyle Waiting time
	Safety	Reduction of traffic accidents Reduction in crime rate Improved cybersecurity Improved data privacy
	Access to (other) services	Access to public transport Quality of public transport Improved access to vehicle sharing solutions Extending the bike route network Access to public amenities Access to commercial amenities Increase in online government services
	Education	Improved access to educational resources Increased environmental awareness Improved digital literacy
	Diversity and social cohesion	People reached Increased consciousness of citizenship and social coherence Increased participation of vulnerable groups
	Quality of housing and the built environment	Diversity of housing types Connection to the existing cultural heritage Design for a sense of place Increased use of ground floors Increased access to urban public outdoor recreation space Increased access to green space
Planet	Energy & mitigation	Reduction in annual final energy consumption Reduction in lifecycle energy use Reduction of embodied energy of products and services used in the project Increase in local renewable energy production Carbon dioxide emission reduction Reduction in lifecycle CO_2 emissions Maximum Hourly Deficit
	Materials	Increased efficiency of resources consumption Share of recycled input materials Share of renewable materials Share of materials recyclable Life time extension
	Water	Reduction in water consumption Increase in water re-used Self-sufficiency - Water
	Land	Increase in compactness Self-sufficiency - Food
	Climate resilience	Climate resilience measures (The extent to which adaptation options have been considered in the project)
	Pollution & waste	Decreased emissions of Nitrogen dioxides (NO_2) Decreased emissions of Particulate matter (PM2,5) Reduced exposure to noise pollution Reduction in the amount of solid waste collected
	Ecosystem	Increase in green and blue space Increased ecosystem quality and biodiversity
Prosperity	Employment	Increased use of local workforce Local job creation
	Equity	Fuel poverty Costs of housing
	Green economy	Certified companies involved in the project Green public procurement CO2 reduction cost efficiency
	Economic performance	Financial benefit for the end-user

Prosperity	Economic performance	Net Present Value (NPV) Internal rate of return (IRR) Payback Period Total cost vs. subsidies
	Innovation	Involvement of extraordinary professionals Stimulating an innovative environment Quality of open data New start-ups Improved interoperability
	Attractiveness & competiti-veness	Decreased travel time
Governance	Organisation	Leadership Balanced project team Involvement of the city administration Clear division of responsibility Continued monitoring and reporting Market orientation
	Community involvement	Professional stakeholder involvement Bottom-up or top-down initiative Local community involvement in planning phase Local community involvement in implementation phase Participatory governance
	Multi-level governance	Smart city policy Municipal involvement - Financial support
Propagation	Replicability & scalability	Social compatibility Technical compatibility Ease of use for end users of the solution Ease of use for professional stakeholders Trialability Advantages for end users Advantages for stakeholders Visibility of Results Solution(s) to development issues Market demand
	Factors of success	Changing professional norms Changing societal norms Diffusion to other locations Diffusion to other actors Change in rules and regulations Change in public procurement New forms of financing Smart city project visitors

WORKSHEET - KPI MODEL	**n°10**

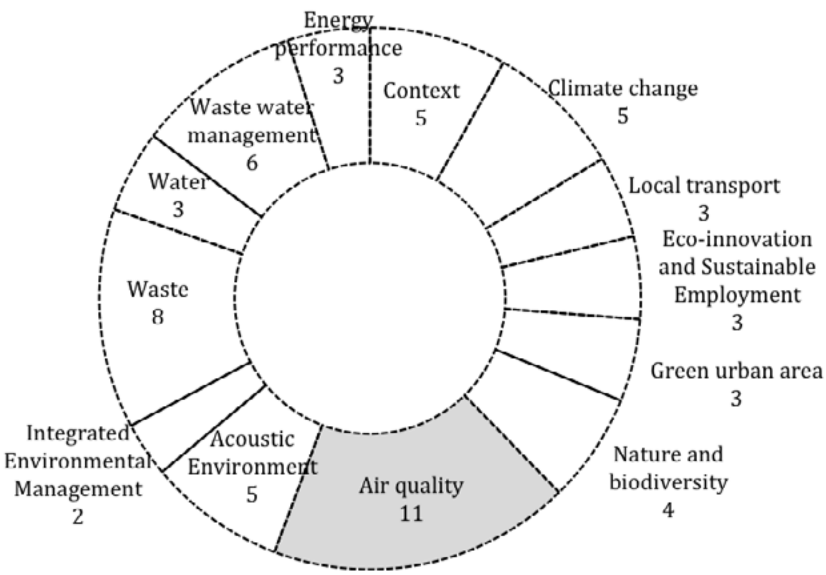
EUROPEAN GREEN CAPITAL

Model main data	**Innovative aspects and strenghts**
☐ Ex ante model ■ Ex post model	• Presence of analysis related to current, past and future situation • Presence of several indicators in main urban sectors • Presence of indicators about different kind of pollution, such as acoustic pollution
☐ Ranking instrument ■ Application for certifications / labels / awards ☐ Rating instrument ☐ Thesis ☐ EU H2020 project ☐ Tool	■ Presence of KPIs ☐ Presence of step-by-step approach ■ Presence of scenarios

Authors and scope

European Green Capital is the application that cities need to fulfill for being candidate as European Green Capital. This worksheet takes into consideration the application for 2019.

Indicators distribution graph



Weak points

The main weak points are, in opinion of this reasearch, the following:
- absence of reference about ICT implementation and monitoring

Main sources: http://ec.europa.eu/environment/europeangreencapital/index_en.htm

Key performance indicators

Theme	Indicators / Points
City Introduction and Context	Population; Area; Population Density; GDP; Köppen climate classification
Climate change: Mitigation and Adaptation	City Reduction Targets Total CO_2 emissions (tonnes) per year CO_2 Emissions / capita CO_2 Emissions / capita for transport CO2 emissions (tonnes) per MWh electricity consumed
Local transport	Proportion of population living within 300 metres of an hourly (or more frequent) public transport service For all journeys under 5km, proportion of these journeys undertaken by: i) car, ii) public transport, iii) bicycle, iv) by foot and v) other Proportion of buses operating in the city that are low emission (at least Euro V)
Green urban areas incorporating Sustainable Land Use	Population density in built-up areas (city area minus green and blue) Percentage of people living within 300m of green urban areas of any size in inner city Population density (inhabitants per hectare) for new developments
Nature and biodiversity	Number and total area of Natura 2000 sites that are located in the city or nearby (i.e. within 10 km) Number and total area of designated sites of national biodiversity importance within the city (habitat/species management areas) Number and total area of designated sites of local (city) biodiversity importance within the city (habitat/species management areas) Biodiversity Action Plan
Ambient air quality	Max Number of days per year on which EU target value for ozone was exceeded (8h mean) Number of ozone monitoring stations Max Number of days per year on which EU target value for PM10 was exceeded (8h mean) Number of PM10 monitoring stations PM10 - Max concentration recorded Number of NO_2 monitoring stations NO_2 - Max concentration recorded NO_2 - Annual Average concentration Number of PM2.5monitoring stations PM2.5- Max concentration recorded PM2.5- Annual Average concentration
Quality of the Acoustic Environment	Share of population exposed to total noise values of Lden above 55 dB(A) Share of population exposed to total noise values of Lden above 65 dB(A) Share of population exposed to total noise values of Ln (night noise indicator) above 45 dB(A) Share of population exposed to total noise values of Ln (night noise indicator) above 55 dB(A) The percentage of citizens living within 300m of quiet areas
Waste production and management	Percentage of household waste sent to landfill Percentage of household waste sent for thermal treatment or similar recovery Percentage of organic waste collected separately Percentage of recycled household waste Percentage of recycled packaging waste Percentage of recovered packaging waste Amount of Household Waste generated per capita Amount of Municipal Waste generated per capita
Water management	Domestic usage - Litres per capita per day Total Usage - Litres per capita per day Water loss in pipelines, leakage management and network rehabilitation
Waste water management	Percentage (%) of total annual generated waste water load, connected to waste water collecting system + urban waste water treatment plants (UWWTPs) N° of WWTP Total Design Capacity (PE) Total Load Received by UWWTP (PE) Total annual generated waste water load of the city (in PE) Treatment level which is applied in each UWWTP: secondary or more stringent; in this case, type of treatment: nitrogen and/or phosphorus removal, disinfection
Eco-innovation and Sustainable Employment	Number of electric vehicles owned by the municipality Number of electric vehicles owned by the municipality (in % of all cars owned by the municipality) Number of charging outlets available for cars owned privately
Energy performance	Final Energy Consumption; Final Energy use/capita; Final Energy usage /sector
Integrated Environmental Management	Signatory of CoM Aalborg Signatory

WORKSHEET - KPI MODEL	**n°11**

100 RESILIENT CITIES

Model main data

☐ Ex ante model
■ Ex post model

☐ Ranking instrument
■ Application for certifications / labels / awards
☐ Rating instrument
☐ Thesis
☐ EU H2020 project
☐ Tool

Innovative aspects and strenghts

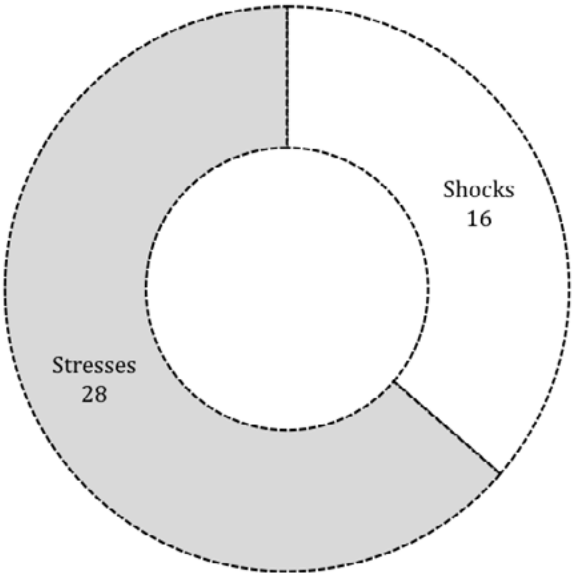
- stress and shock are also related to social and economic resilience and not only to climate resilience
- the application can help cities in focusing on major challenges

■ Presence of KPIs
☐ Presence of step-by-step approach
☐ Presence of scenarios

Authors and scope

100 Resilient Cities is an application created by the Rockfeller Foundation, in order to become part of a selection of worldwide cities active in the field of mitigation of climate change and, in particular, in implementing measures for the urban resilience increase. The application is composed by several questions aiming to highlight stresses and shock that city have or had in the past.

Indicators distribution graph



Weak points

The main weak points are, in opinion of this reasearch, the following:
- the resilience addressed into this process is mainly due to un-expected events (such as land slides, earthquakes, etc.)
- the application is strict on a pre-selection of shocks and stresses (municipalities can only choose among the presented possibilities)

Main sources: http://www.100resilientcities.org/

Key performance indicators

Theme	Elements
Shocks	Selection of four shocks among the following: blizzard, coastal flooding, heat waves, landslides, cyber attack, wildfire, disease outbreak, rainfall flooding, hurrican, thypoon, cyclone, riot and civil unrest, tsunami, earthquake, hazardous material accident, infrastructure failure, terrorism, volcanic activity
Stresses	Selection of four stresses among the following: aging infrastructure, declining population, endemic crime and violence, high unemployment, intractable homelessness, lack of social cohesion, political instability and/or sectarian violence, pronounced poverty, rising sea level and coastal erosion, water management issues, chronic energy shortages, aging population, epidemic of drugs and alcohol abuse, impending depletion of natural resources, invasive species, overpopulation, poor air quality and pollution, inequality, shifting macroeconomic trends and/or over relience on one industry, commodity price fluctuation, drought and water shortage, food shortage, insufficient educational infrastructure, lack of affordable housing, overtaxed / underdeveloped / unreliable transport system, poor health infrastructure, refugees, significant environment degradation and / or air/water pollution

WORKSHEET - KPI MODEL	**n°12**

RESILIENCE INDICATORS (CUTTER METHOD)

Model main data

■ Ex ante model
☐ Ex post model

☐ Ranking instrument
☐ Application for certifications / labels / awards
☐ Rating instrument
☐ Thesis
☐ EU H2020 project
■ Tool

Innovative aspects and strenghts

- evaluation on an ex ante perspective of urban situation about resilience
- presence of variables divided in main sectors

■ Presence of KPIs
☐ Presence of step-by-step approach
☐ Presence of scenarios

Authors and scope

This method, based on a series of scientific papers published by Cutter et al. from 2008 to 2010, is intended to measure present conditions of a system influencing disaster resilience within communities. The main interest on this method relies in being "one of the first empirically based efforts to benchmark the pre-existing conditions that foster community resilience".

Indicators distribution graph

Weak points

The main weak points are, in opinion of this reasearch, the following:
- the resilience addressed into this process is mainly due to un-expected events
- no specific focus on climate resilience
- no specific focus on actions related to situation analysis

Main sources: Cutter, Susan L.; Burton, Christopher G.; and Emrich, Christopher T. (2010) "Disaster Resilience Indicators for Benchmarking Baseline Conditions," Journal of Homeland Security and Emergency Management: Vol. 7: Iss. 1, Article 51. DOI: 10.2202/1547-7355.1732
Cutter, S. L., Boruff, B. J. and Shirley, W. L. (2003), Social Vulnerability to Environmental Hazards*. Social Science Quarterly, 84: 242–261. doi:10.1111/1540-6237.8402002

Key performance indicators

Theme	Variable	Description
Social Resilience	Educational equity	Ratio of the pct. population with college education to the pct. population with no high school diploma
	Age	Percent non-elderly population
	Transportation access	Percent population with a vehicle
	Communication capacity	Percent population with a telephone
	Language competency	Percent population not speaking English as a second language
	Special needs	Percent population without a sensory, physical, or mental disability
	Health coverage	Percent population with health insurance coverage
Economic Resilience	Housing capital	Percent homeownership
	Employment	Percent employed
	Income and equality	GINI coefficient
	Single sector employment dependence	Percent population not employed in farming, fishing, forestry, and extracti-ve industries
	Employment	Percent female labor force participation
	Business size	Ratio of large to small businesses
	Health Access	Number of physicians per 10,000 population
Institutional Resi-lience	Mitigation	Percent population covered by a recent hazard mitigation plan
	Flood coverage	Percent housing units covered by NFIP policies
	Municipal services	Percent municipal expenditures for fire, police, and EMS
	Mitigation	Percent population participating in Community Rating System for Flood (CRS)
	Political fragmentation	Number of governments and special districts
	Previous disaster experience	Number of paid disaster declarations
	Mitigation and social con-nectivity	Percent population covered by Citizen Corps programs
	Mitigation	Percent population in Storm Ready communities
Infrastructure Resilience	Housing type	Percent housing units that are not mobile homes
	Shelter capacity	Percent vacant rental units
	Medical capacity	Number of hospital beds per 10,000 population
	Access/evacuation potential	Principle arterial miles per square mile
	Housing age	Percent housing units not built before 1970 and after 1994
	Sheltering needs	Number of hotels/motels per square mile
	Recovery	Number of public schools per square mile
Community Capital	Place attachment	Net international migration
		Percent population born in a state that still resides in that state
	Political engagement	Percent voter participation in the 2004 election
	Social capital religion	Number of religious adherents per 10,000 population
	Social capital – civic involve-ment	Number of civic organizations per 10,000 population
	Social capital – advocacy	Number of social advocacy organizations per 10,000 population
	Innovation	Percent population employed in creative class occupations

WORKSHEET - KPI MODEL	n°13

ELITE - TOOL FOR ECO AND LOW CARBON CITIES

Model main data

☐ Ex ante model
■ Ex post model

☐ Ranking instrument
☐ Application for certifications / labels / awards
☐ Rating instrument
☐ Thesis
☐ EU H2020 project
■ Tool

Innovative aspects and strenghts

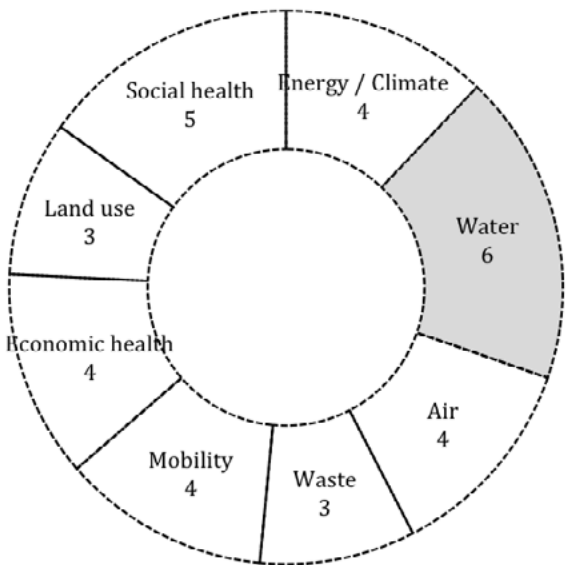
- open source tool giving a final index and a spider graph of urban situation
- the tool can be used in time simply by modifying the indicators values

■ Presence of KPIs
☐ Presence of step-by-step approach
☐ Presence of scenarios

Authors and scope

ELITE is a tool for evaluating Chinese cities according to a selection of indicators about sustainability at the city level. It is sponsored by the U.S Department of Energy. It is open source and shared as an Excel interoperable tool.

Indicators distribution graph



Weak points

The main weak points are, in opinion of this reasearch, the following:
- several themes about urban quality are not included
- several indicators about digital implementation and available services are not included

Main sources: Gang He et al. (2013), ELITE Cities: A low-carbon eco-city evaluation tool for China, ECEEE SUMMER STUDY proceedings; https://china.lbl.gov/tools/eco-and-low-carbon-indicator-tool-evaluating

Key performance indicators

Theme	Indicator	U.M.
Energy / Climate	CO2 Intensity	Total CO2 emissions/capita
	Residential Building Energy Intensity	kWhe/m2/year
	Public Building Electricity Intensity	kWh/m2/year
	Share of Renewable Electricity	% of total electricity purchased
Water	Municipal Water Consumption	liter/cap/day
	Industrial Water Consumption	liter/annual 10,000 RMB
	Wastewater Treatment Rate	% of total waste water
	Drinking Water Quality	% of total drinking water
	Recycled Water Use	% of total municipal water
	Energy Intensity of Drinking Water	kWhe/l
Air	PM10 Concentrations	Daily average PM10 concentration - ug/m3
	NOx Concentrations	Daily average NOx concentration - ug/m3
	SO2 Concentrations	Daily average SO2 concentration - ug/m3
	Air Pollution Days	% of total days per yea
Waste	Municipal Waste Intensity	kg/capita/year
	Municipal Waste Treatment Rate	% of total collected MSW
	Industrial Recycling Rate	% of industrial solid wastes
Mobility	Public Transportation Network Penetration	km/km2
	Public Transportation Share of Trips	% of all trips/year
	Access to Public Transportation	Percentage of built area within 500 meters of public transit
	Municipal Fleet Improvement	Proportion of energy efficient and new fuel vehicles (electric, hybrid, biofuel, <1.6 liters and below cars) in the city vehicle fleet and taxi fleet
Economic health	Employment	Registered unemployment rate
	Environmental Protection Spending Ratio	% of annual GDP
	R&D Investment Ratio	% of annual GDP
	Organic Certification of Agricultural Land	% of agricultural land
Land use	Green Space Intensity	m2 of green space/capita
	Share of Mixed Use Zoning	% of total area
	Population Density	m2/capita
Social health	Health Care Availability	Health care practitioners per 1000 persons
	Share of Workers from Higher Education	% of employed persons
	Internet Connectivity	% of households
	Eco-city Planning Completeness	Eco-city planning and policy completeness
	Affordable Housing Availability	% of total housing

WORKSHEET - KPI MODEL	**n°14**

SMART CITY READINESS GUIDE

Model main data

■ Ex ante model
☐ Ex post model

☐ Ranking instrument
☐ Application for certifications / labels / awards
☐ Rating instrument
☐ Thesis
☐ EU H2020 project
☐ Tool

Innovative aspects and strenghts

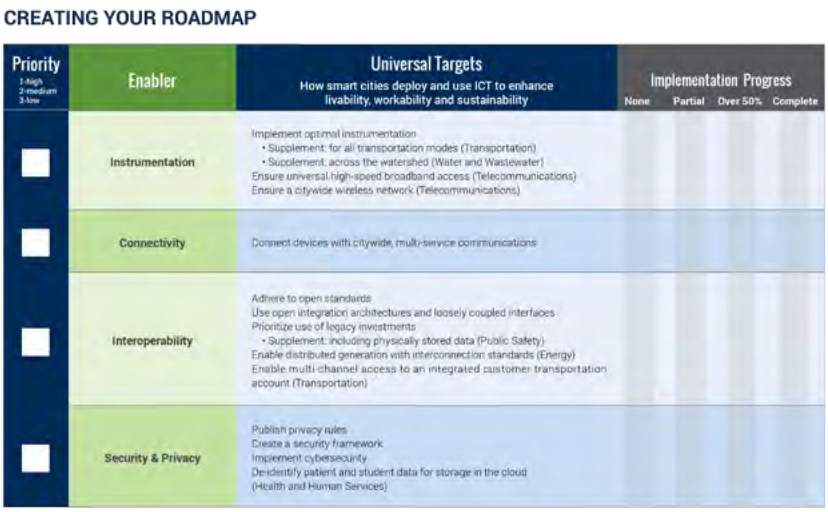
- analysis of current state of the art
- analysis of main trends, barriers and ICT enablers
- presence of worksheets linking enabler with objectives and priorities

☐ Presence of KPIs
☐ Presence of step-by-step approach
☐ Presence of scenarios

Authors and scope

The model has been written in 2013 by the Smart City Council with the aim of giving a view on the state of the art about smart cities, but also of giving a holistic methodological approach for smart processes implementation. After the definition of SC barriers, elements and trends, the approach links together ICT enablers with main urban themes, by giving specific insight on how to improve them. At the end a worksheet is provided for tracking progress in projects implementation. An example of this is given in the following picture.

Main graph



CREATING YOUR ROADMAP

Priority (1-high, 2-medium, 3-low)	Enabler	Universal Targets — How smart cities deploy and use ICT to enhance livability, workability and sustainability	Implementation Progress: None	Partial	Over 50%	Complete
☐	Instrumentation	Implement optimal instrumentation • Supplement: for all transportation modes (Transportation) • Supplement: across the watershed (Water and Wastewater) Ensure universal high-speed broadband access (Telecommunications) Ensure a citywide wireless network (Telecommunications)				
☐	Connectivity	Connect devices with citywide, multi-service communications				
☐	Interoperability	Adhere to open standards Use open integration architectures and loosely coupled interfaces Prioritize use of legacy investments • Supplement: including physically stored data (Public Safety) Enable distributed generation with interconnection standards (Energy) Enable multi-channel access to an integrated customer transportation account (Transportation)				
☐	Security & Privacy	Publish privacy rules Create a security framework Implement cybersecurity De-identify patient and student data for storage in the cloud (Health and Human Services)				

Weak points

The main weak points are, in opinion of this reasearch, the following:
- enablers are mainly ICT instruments, rather than a more complex panel of solutions
- the worksheet could habe been implemented on a step-by-step approach

Main sources: Berst, J., Enbysk, L., Williams, C., & Caine, C. (2013). Smart Cities Readiness Guide, 281. Retrieved from http://smartcitiescouncil.com/resources/smart-cities-readiness-guide

Main model elements and themes

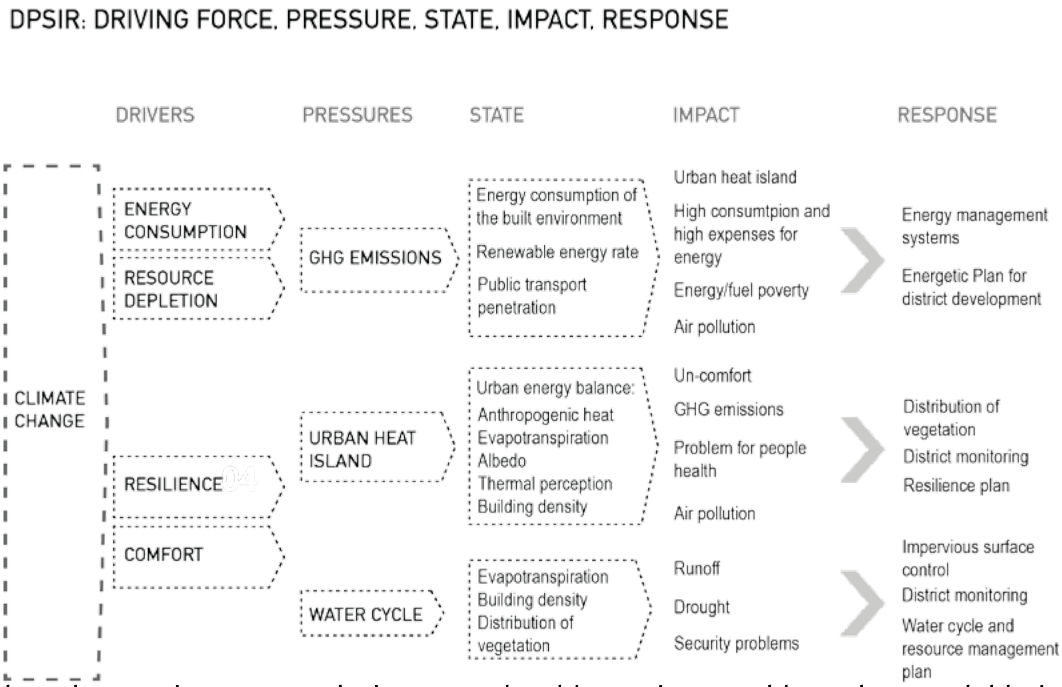
Themes / Elements	Indicator
Smart City vision: "three core functions of a smart city"	1. Collecting data "Smart devices are logically located throughout the city to measure and monitor conditions."
	2. Communicating data "Smart cities typically mix and match a variety of wired and wireless communications pathways, from fiber-optic to cellular to cable. The ultimate goal is to have connectivity everywhere, to every person and every device."
	3. Crunching data "After collecting and communicating the data, you analyze it for one of three purposes: 1) presenting, 2) perfecting or 3) predicting."
Smart City drivers	Growing urbanization Growing stress Inadequate infrastructure Growing economic competition Growing expectations Growing environmental challenges Rapidly improving technology capabilities Rapidly declining technology costs
Smart City barriers	Siloed, piecemeal implementations Lack of financing Lack of ICT know-how Lack of integrated services Lack of citizen engagement Lack of a smart city visionary
Smart City benefits	Enhanced livability Enhanced workability Enhanced sustainability
City Responsibility (themes subdivision)	Built environment Energy Telecommunications Transportation Health and human services Water and wastewater Public safety Payments
Enablers	Instrumentation and control Connectivity Interoperability Security and privacy Data management Computing resources Analytics

Conclusions of Section 1

A selection of KPIs for addressing Smart Green Cities development: a DPSIR approach

The research identifies a major set of 11 indicators aiming to meet urban challenges and overcoming theoretic barriers among smart, green and sustainable approaches. In order to achieve this goal, a brief analysis of urban system requirements has been done. As in the present research, indicators are aimed at addressing the design of resilient, smart, green and sustainable districts, it is important to link those indicators with a set of requirements that complex urban systems seems to have. If it is possible to divide urban complex systems in several units, such as buildings, energy infrastructures, resource infrastructures, streets, digital infrastructures, community and governance, it is also reasonable to affirm that each of these units needs to answer to each of the following requirements: 1) wellbeing (which can be community wellbeing on the community dimension, but also inside buildings, etc.); 2) security (which can be stability of infrastructure, but also cyber security, etc.); 3) usability; 4) external aspect; 5) integration (of systems and infrastructures, but also social integration); 6) management; 7) sustainability and environment protection (including non renewables resources); 8) inter-operability among units; 9) intelligibility, data collection and monitoring; 10) automation. Some of them are the result of a 1990s research conducted by (Landini, Rota, 1989) and some are the result of a reflection about common urban contexts. Based on this consideration a major set of indicators can be defined,

Figure 3 .4 DPSIR scheme



but the requirement analysis can make this set increasable and expandable in case of need. This means that the set of indicator must be the reflection of the analysis on urban complex requirements, which can upgrade in time.

On the basis of this consideration a primary set of 11 indicators has been identified:

- Energy consumption of buildings
- Renewable energy
- Building density and canyon geometry
- Anthropogenic heat
- Evapotranspiration
- Thermal comfort
- Quality of vegetation
- Air quality
- Green mobility
- ICT devices
- Innovative environment

Indicators 1 and 2 refer to the energy efficiency main topic; indicators 3-4-5-6-7 refer mainly to microclimate assessment; indicators 7-8-9 to natural environment; indicator 10 to ICT and indicator 11 to the innovative ecosystem. All the indicators are referred to the district dimension and not to singular buildings or components.

Figure 3.4 links the first set of indicators trying to clarifying the interrelations between driving force – pressure – state – impact – response (DPSIR), as developed by the OECD and the EEA (European Environment Agency, 1999; OECD, 2001, 2008). The DPSIR framework examines the linkages between human activities, urban evolution, mitigation to climate change and the role played into this context by technology. It is a useful tool for reporting this relationship as well as helping to develop potential solutions. It contributes to a better understanding of the selection of indicators that are relevant to Green city assessment and also provides a conceptual basis for the policy need and the scenario analysis.

The district as a dimension for accelerating the transition

The debate on district as a pilot dimension for testing solutions has been discussed from several years. In particular, the identification of what a district is, and what are its boundaries, it is an interesting discussion (Balducci & Fedeli, 2007). From this debate, several features can define the district:

- The **geographical dimension**. A district is, per definition, a portion of a city, which has specific geographical boundaries. These boundaries can be physical or social or economic or functional. The geographical limitation of strategy's application is useful for testing solution in a limited environment. Of course, this may not be auto-conclusive, but it needs to lead to a replication and up-scaling phase (Directorate-General for internal policies- European Parliament, 2014).
- The **social dimension**. A district can be named also neighbourhood and, with this specification, it is intended a portion of a city having a characteristic and specific social dimension. This could be the presence of a particular and homogeneous community, or conversely a inhomogeneous community with –or without- social constraints.
- The **administrative dimension**. A district has often an administrative recognition, or it is recognised by the rest of the city as an unitary dimension. This fact can be useful for policy implementation, for city-branding, for recognising immediately some specific features, policies and laws that can be applied to the selected district.
- The **functional dimension**. Into the history, sometimes districts had had specific functions. The 1990s cities were often divided into different functional areas: commercial areas, located around the city centre, in general along highways; productive areas, as well, located far from the city centre, and quickly reachable

with highways; residential areas; touristic / artistic / historical city centre or tertiary city centre.

This is the main frame about district definitions and boundaries. The present research focuses on the characteristic of the intermediate dimension between buildings and cities, as the district is, to be a good and defined dimension for testing innovative solutions. But, it is clear that the application of such strategies on districts cannot be scaled-up 1:1 inside the whole city, as well as the testing of solutions inside several districts cannot make the whole city smart.

The operational definition of district and neighbourhood, used into this research, takes into account all the previous highlighted elements[1]. In addition, the two terms are used here as synonyms because it is opinion that the project on a portion of city must include the social dimension. Generally, in fact, the word neighbourhood tends to identify a social identity inside a physical urban space (Barton, 2000).

So far, with district and neighbourhood it is intended an intermediate urban dimension between the entire city and the building dimension having the following characteristics:

- a social specification, in other term a recognizable community living inside (with or without social constraints);
- a minimum dimension for implementing effective and integrated strategies on buildings, open space and local mobility dimensions. In other term, a too small district may be not sufficient for this kind of projects. Nevertheless it isn't possible to settle a quantitative and specific dimension and each case can be different;
- a settled functional vocation, coming from the history of the city or from former functions: mixed-use district or residential, touristic, commercial or industrial, etc. vocation;
- a recognised relevance (dimensional, administrative) in respect of the whole city.

To sum up, the following characteristics are also important to be considered in relation with district dimension selection, in order to meet the following characteristics:

- the selected district is a loop (a junction) of an ensemble composed by buildings (nodes) and infrastructures (networks);

1 See (Barton, 2000; Chastenet et al., 2016; Lefevre & Sabard, 2009).

• actions on districts involve people, mobility, infrastructures and buildings in an integrated and multi-layered approach;

• a monitoring phase is consistent in respect of the dimension of the selected area for giving information about urban performances and people behaviour.

From smart toward an integrated green city approach

To sum up, the research analysed the main meanings of the expression SC into the literature, highlighting the historical foundation of the concept and how scientists are pursuing researches into the topic (chapter 1). Then, the research focused on the evaluation of SC projects in European cities (chapter 2) and tried to understand which are the main key performance indicator behind the construction of a SC (chapter 3). So far, it is possible to underline some key features behind all these elements, and among all one major concept seems to frame all current approaches about SC. At first, in fact a SC is considered as "more than the sum of its projects. Rather, it needs a fertile environment guided by a clear vision, the participation of relevant actors (people), and the efficient and effective organisation of its processes" (Directorate-General for internal policies- European Parliament, 2014, p. 78).

As set by the (Directorate-General for internal policies- European Parliament, 2014) the success factors of a SC can be listed as following:

• **Presence of a clear vision**. Each city needs to answer for itself to the question of what are the main aims and the main targets to be achieved? A city needs to have clear in mind its vision of what would be the city like in the mid and long term perspective.

• **Citizens' and stakeholder's participation**. This element is fundamental for the success of SC initiatives: there is a big difference among top-down and bottom-up approaches with strengths and weaknesses for each model. In general, the top down approach guarantees a clearer vision from decision makers, while the bottom up guarantees a deeper citizens' participation. The stakeholder involvement must also be efficient and the selected stakeholders need to be effective with the initiative, also in order to ensure the credibility of the initiative.

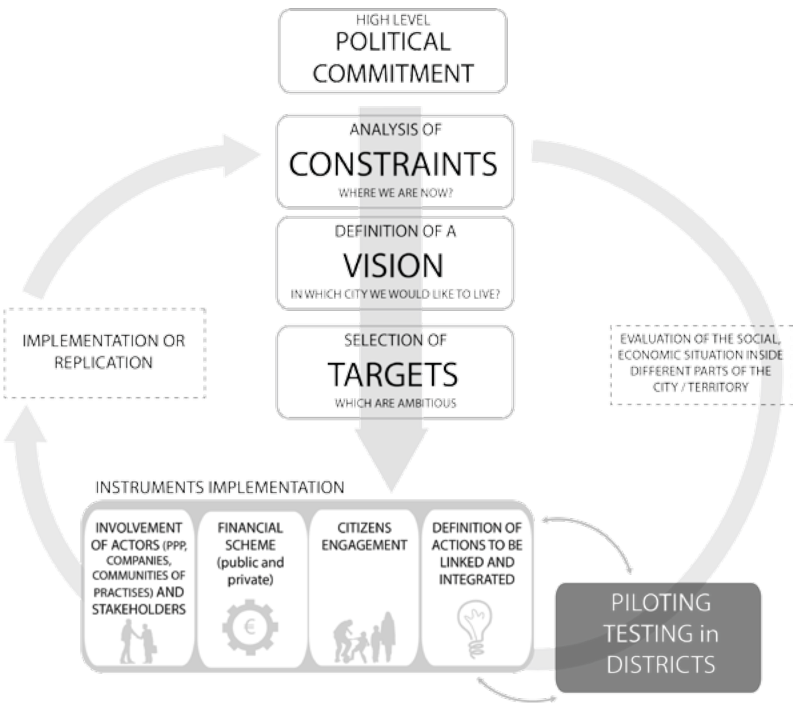
• The **effectiveness of the process**. A good process has a good management structure, as well as a good evaluation and monitoring phase and a structure for knowledge management.

• In addition, the research focuses, as an additional key success factor, on the presence of a good and effective **set of key performance indicators** with

Table 3 . 3 Smart city and its extensions. An analysis of boundaries and connections

Innovation & smartness	The smartness is usually linked with innovation. Smart processes are often underlying innovative technologies application or innovative business models, for making the initiative more efficient and effective on the long-term perspective.
Sustainability & smartness	The smartness is linked with sustainability as it is evaluated into this research as one of the possible way to address mitigation and adaptation to climate change. The implementation of smart strategies in a city must consider the major goal of achieving the transit toward low-carbon and more sustainable societies.
Resilience & smartness	Resilience, as well as sustainability, is one of the main goal of smart processes. Acting on the city dimension, means also to address the ability of the urban context to react and adapt to climate change.
Technology & smartness	Technology is a common used major component of smart initiatives. Into this research technology is not only considered as ICT technology, but as the extended meaning of the concept. With this consideration, the technology can be seen as an enabler of SC initiatives.
Architecture & smartness	Architecture is not often considered as a discipline included into the SC approach. However, the research aims to show the important role of this discipline, on a multi-approach and multi-disciplinary perspective, as SC approaches act on the urban physical space, which is normally the field of study of architects.

Figure 3 .5 Regional SC approach analysis



the aim to correctly and precisely evaluate the quality and the scalability of the initiative.

Table 3.2 Secondly, the SC concept is often placed near other concepts linking to other major urban challenges. Some of these connected concepts are, in a glance, briefly resumed into table 3.2. The research also highlights how the definition of SC is seeing a double interpretations:

- on one hand, in fact, common knowledge about SC tends to indentify more and more SC with ICT technologies and, more in general, with a high technological concentration (ICT, digital or other technologies);
- on the other hand, Europe and scientific documents tends to ask for integrated approaches aiming at accelerating urban transition toward low carbon.

This element evidences the necessity of extending the analysis of such strategies by going toward the boundaries of SC definition, in order to meet a wider definition of Green Cities including the following aspects:

- green, sustainable and ecological approaches. These approaches include the wide use of green elements inside urban planning but also considerations about materials sustainability (even LCA and LCC perspective), process sustainability, ground permeability, helthcare, etc.
- Smart approach including tehcnologies (ICT, KETs, infrastructures technologies, etc.) implementation and effective processes.
- Resilient approach inlcuding reflections both about unexpected events (earthquakes, thyphoons, etc.) and about climate change related events (heat islands, floodings, etc.).
- Integrated and multi-disciplinary approach, including reflections about integration of several disciplines in a holistic, time-related, scenario bounded approach.

Third, the analysis, in the two first chapters, put in evidence some barriers that SCs meet when are implemented into real context. In part these barriers were highlighted into the research of (Berst et al., 2013) and they are resumed into the following list:

1) lack of complete and clear vision on the future of the city;

2) consequent frequent lack of targets selection;

3) difficulties in avoiding the silos-thinking;

4) lack of financing;

5) lack of systems integration and compatibility both in the ICT sector, but also in other systems (e.g. compatibility in the field of smart grids, among sensors

Figure 3 .6 Local approach leading to multi-variate approaches

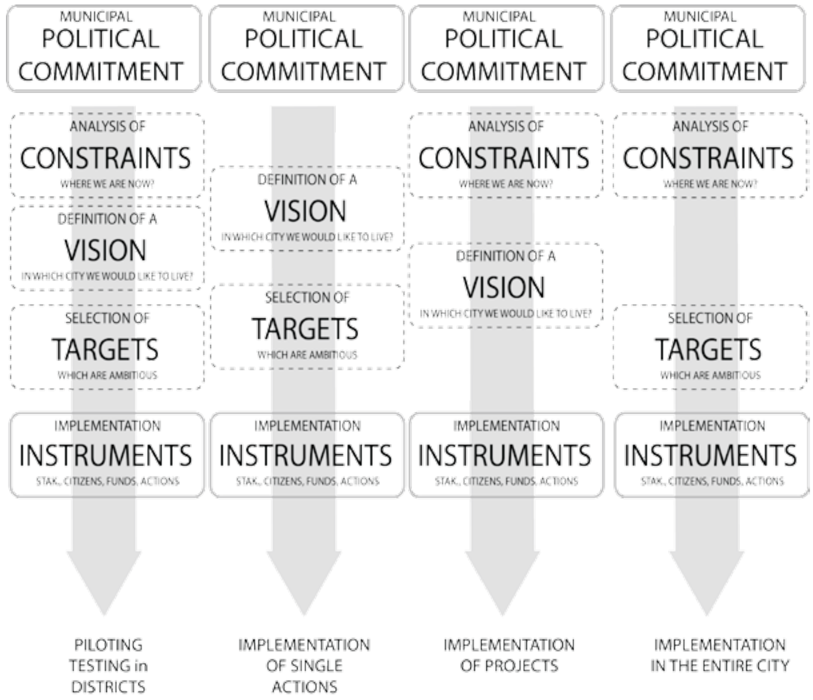
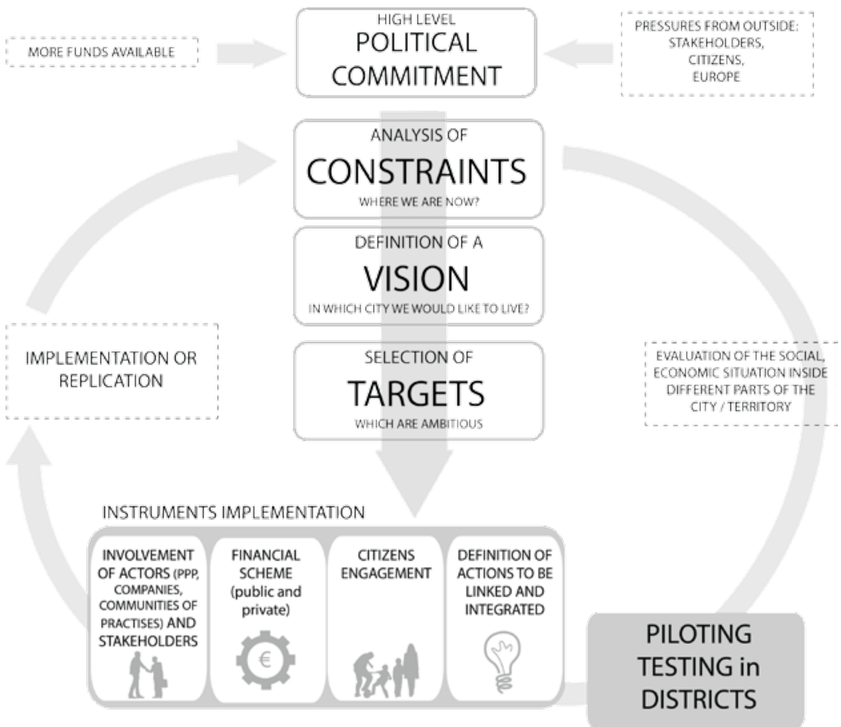


Figure 3 .7 Big cities approach analysis



and applications, etc.);

6) lack of ICT know-how and citizen engagement.

These barriers have to be considered in developing SC approaches and models in cities, because they can influence the success or the failure of the approach.

The last important element that the research aims to highlight is the existing difference between typologies of cities, in term of approaches. The case studies analysed put in evidence these differences, which can be visualized in the following schemes and description:

1) one approach can be called the "**regional approach**": the implementation of the SC starts from a high political commitment that aims to frame the entire region / country where it acts. It is, for example, the case of the Denmark and Portugal, but several other territories use the same (e.g. the Netherlands). It is mainly a top down approach starting from the definition of visions and setting of ambitious targets (Fig. 3.5). This approach is common in countries or region, which are not too big, where there is a high political commitment and where the attention on SC and sustainable themes were already present in the past and are the result of long term analysis.

2) Another approach can be called "**multi-variate or local approach**": there isn't a high political commitment on the national level, but more on the municipality level. In these cases, a plurality of municipalities have a mayor (or decision makers) aware of climate change and of the need to improve city life who push the start of SC processes (Fig. 3.6). As a general framework, it is the case of territories with lot of medium-sized cities, starting to be interested into the development of such projects. The Italian case is an example of this situation, but other similar situations can be found for example in French and Spain.

3) the last approach can be called "**big cities approach**" and it is the case of metropolis and very big cities. Into this environment the political commitment can be on the national level or on the metropolis level: the main aspect is the pressure that such cities have into demonstrating and giving the example to other cities in good practises. Metropolises generally also have more stakeholders pressing to have a specific environment and more funds than medium-sized cities (Fig. 3.7). This is for example the case of Paris, but also of London, New Yorks, etc.

This analysis is not to be intended as a complete analysis of all the possible approaches, but only the transposition of observations based on the analysing the selected case studies. Into future researches, this analysis will be extended and verified on the base of a wider case study analysis and on the base of interviews to cities energy managers.

As a conclusion of the analytical section of this work, an outline of the main goals of the research that will be founded into the following section is done here. **The research aims to develop a tool for addressing the design and the assessment of SC at the district level.** Consequently, in the present research, the SC is conceived as a process instead of a specific project. This is because each city is different and it is not possible to address the same projects in all cities. As the replication and scalability of strategies is nowadays fundamental for achieving the major goal of transit toward low-carbon societies, the development of holistic approaches must pass through the definition of a replicable process instead of a project. In addition, the research decided to extend the definition of SCs toward the definition of integrated Green Cities, as outlined above. In the following section, the presentation of the proposed model with a double set of KPIs is presented with the examination of a simulation into a real context.

SECTION 2

4 Green City Circle. KPI-based model for built environment regeneration

This chapter introduces the main research contribution: a decision making model for addressing the GC processes. The first section presents the theoretical framework, the workflow of the Green City Circle (GCC) model and its objectives. The second section describes in detail the selection of key performance indicators (KPI). And the third section presents the description of GCC's six steps by which the model is composed.

4.1 A theoretical framework

The purpose of this study, as discussed into the previous section, is to investigate a process for urban regeneration on a Green integrated perspective. The literature review has shown the necessity of increasing the effectiveness of urban actions in order to meet more and more pressing energy and efficient targets. In addition, the limitation of budget that several municipalities generally have to face, shows the necessity of more efficient actions (OECD, 2012). This paragraph highlights the theoretical framework of the GCC model proposed as the main original output of this research.

The Organisation for Economic Co-operation and Development (OECD, 2008, p. 24) describes the theoretical framework as a starting point for constructing indicators. In particular it is important to clearly define the phenomenon we want to analyse and measure. As well, (Sinclair, 2007) explains that developing a theoretical approach pass through the identification of questions to be used to guide the research. When developing a model for decision makers, a theoretical framework is necessary for understanding what is likely to be measured instead of what are the available data. The framework identifies some main objectives of the model underpinning the methodological approach applied. Accordingly, it clarifies the relevant indicators related to the desirable outcomes followed by the development of visions and strategies.

Firstly, as widely explained into chapter 3, the SC is conceived as a complex system where the smartness is not only related to the result of a designing and strategic project, but more on the process that decision makers or municipalities put in place. In addition, as already evidenced in chapter 2, this research consider the development of SC in a wider sense, including also green, sustainable and resilient approaches and by using, as a consequence, the definition of Green Cities. In particular, as highlighted into the Conclusions of Section 1, a smart green integrated process includes not only the definition of a number of actions to be applied on a city, but also several additional elements: a timing approach, which includes the definition of a time-bounded target on a long term perspective and a series of milestones into the evolution of the time; a stakeholder engagement, which includes citizen engagement and participation to the design process; a budget approach, which could be enhanced by the definition of innovative business models. Into this context, the technology is seen as an instruments with which the process can be carried out, for example through the use of platforms or simulation tools or with the implementation of specific technological or ICT devices or products.

As a limitation of the field of investigation and as explained in Conclusion of Section 1, the application of the strategy is selected to be the district scale. As a consequence, the tool, needing to better address the decision of actions leading to an effective transition toward low carbon, is conceived as a **decision-making model based on KPIs and on scenario analysis**.

The context where the model is applied is the city, which is a very complex system as explained by (Michael Batty, 2008). The reason of this complexity is manifold:

- the evolutionary state of urban contexts, due to the societal pressing needs, leading to rapid changes, to economic evolutions, to technological implementation and to political evolution.
- The speed of actual society, asking for immediate solutions to emergent

problems and needs.

- The city is a multi-actor environment, where a number of different stakeholders have an important role into the evolution and cities transformation: not only stakeholders, but also citizens, SMEs, start-ups, industries, associations, etc.
- The city is a multi-layered structure, where several elements contribute to the formation of an organic ecosystem: buildings, infrastructures, communities, spaces concur to form the essence of the urban reality.
- The interrelation of systems' parts produce and interdependency of all elements, producing a direct and indirect cause-effect: if some changes occur in one part of the system, all the other parts will be affected in different ways and gradient of intensity (Batty, 2008; Antonini et al. 2015).

As set by Bernardo Secchi, in several papers and reflexions, current instruments of urban planning are the result of an enormous urban growth caused by the availability of natural and economic resources, as well as by a fuel-based society. Today, these instruments, composed by a set of prescriptions, usually expressed in graphic and verbal form, are no more expression of a real need (Secchi, 2003a)[1]. In consequence, there is a need for new methodologies, giving the evidence of new complexity of urban planning, related to a long-term perspective[2] (Directorate-General for internal policies- European Parliament, 2014, p. 105).

As a consequence, the main objectives of the GCC model are the following:

- Establishing a complete step-by-step methodology, through the definition of a circular process. Into this process, targets and specific outputs characterize each phase.
- Providing a long-term perspective, forcing the decision makers to set time-

1 The project for the city has as its central issue the new configuration of the entire urban structure that cannot rely upon consistent urban expansion as much as upon a set of precise and limited interventions. These are not only limited spatially, but are also limited in terms of the actors and resources that are mobilized and their necessary time-frames. Unlike the past, this has changed the premises, methods of construction and representation of the project for the city; but what has changed above all is the process by which hypotheses can aspire to their realization; and more in general, its place in society has changed. (Secchi, 2003a, p. 2)

2 The principal condition necessary for a renovatio urbis policy to acquire meaning and coherence - so that the interests of the active subjects are not only represented in the set of actions for its realization but also a coherent strategic map where social utility can be shown - is that the same actions are placed naturally within a shared long-term vision. (Secchi, 2003b)

bounded targets, milestones and measurable objectives (SMART[3] objectives).

- Providing alternative scenarios of development, allowing actors involved into the process to choose the best solution for the context of application.
- Improving the quality of district through the implementation of a holistic approach analysing different sectors togheter.
- Improving the efficiency and the resilience of district through the implementation of mitigation and adaptation strategies.
- Improving knowledge on the urban system promoting the application of monitoring strategies.

As defined by a number of authors, actual design methods present some emerging needs. In particular the following:

- a complete evaluation systems acting during the design phase, in order to work in complementarity with timing, budget allocation, stakeholder engagement and the creation of visions (Directorate-General for internal policies- European Parliament, 2014, p. 105).
- models and systems able to help municipalities and decision makers to face the efficient allocation of budgets in effective projects for improving low carbon contexts (European Union, 2011; also see Interview n°2 , p. 366).

Into this study, a model for the urban design is developed to drive the exploitation of urban regeneration toward low carbon societies and through the implementation of smart processes and visions. The model entitled **Green City Circle** is a KPI-based step-by-step model, investigating the process of creating a vision and implementing it on the existing urban district dimension. The model outputs give two complementary elements for the design support:

- a set of visions aiming to show possible evolutions of current situations and to evaluate which can be the best solution;
- an implementation plan for sustainable and more efficient districts with specific regard to resilience, sustainability and energy efficiency.

As defined in Conclusion of Section 1 (p. 192), the district is conceived as the main unit of application being an intermediate scale between building dimension and the whole urban dimension. It allows the analysis of the specific interrelations between buildings and between building and open spaces. The model is furthermore based on scenario analysis, which allows the formulation of alternative visions and ideas, by putting in place different strategies and

3 SMART: Specific, Measurable, Assignable, Realistic, Time-related.

simulating hypothetical different results on a long-term period and on a multi-step dimension. The model outputs provide a set of reporting guidance to help policy-making and municipalities in developing smart processes and design phases.

4.1.1 A KPI and scenario based model

The GCC model is developed on different steps. In particular two main elements need a further theoretical framework: KPI selection methods and scenario development methods.

As shown in Figure 4.1, the first step of the GCC model answers to the question "what is being measured?" which was defined referring to the theoretical framework based on the literature review. The second step was data collection and analysis of case studies, linking the theoretical framework with the selection of KPI and the definition of data collection methods. This section answers the question of "how it is being measured?".

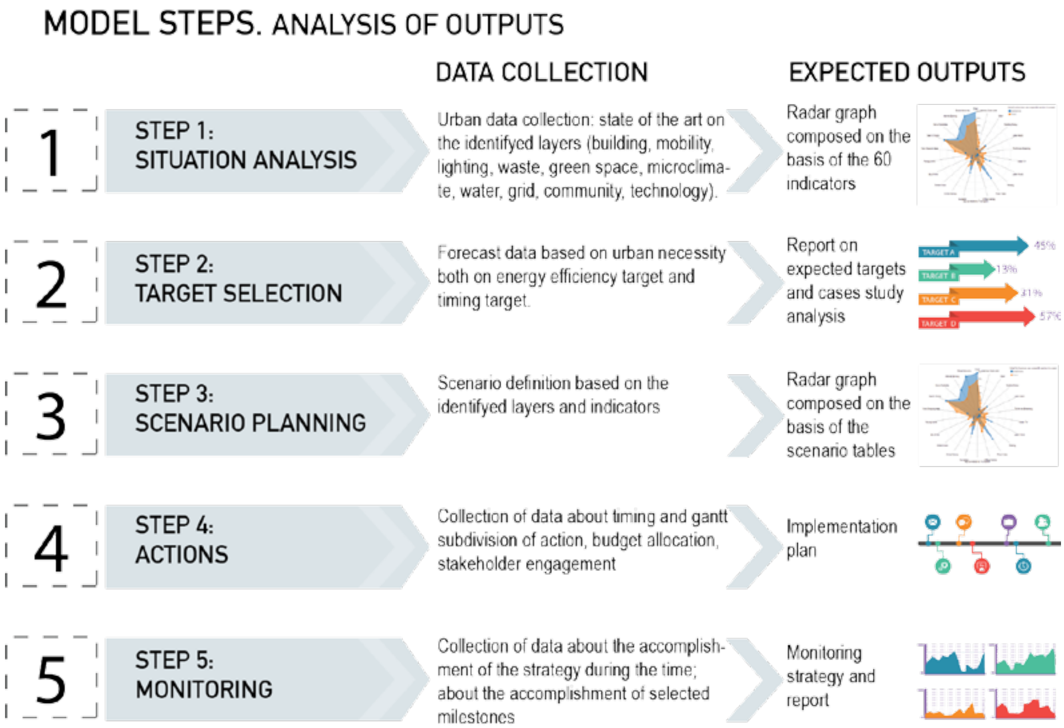
The definition of indicators was produced according to the guidelines offered by the OECD (2008). As the output of the model is not a composite indicator or a comprehensive index, some steps, set by the OECD, were omitted. In fact, the output of the model was selected to be the evaluation of different scenarios on a comparative approach.

Anyway, the methodological approach for the composition of indicators follows different steps:

- definition of the theoretical framework to understand the multidimensional phenomenon under analysis (see paragraph 4.1.1 , p. 209 and see paragraph 4.1.2 , p. 211);
- selection of indicators according the their relevance, analytical soundness, measurability and coverage (see paragraph 4.2 , p. 212);
- analysis of data collection and definition of spatial analysis;
- reflection on missing indicators;
- normalisation of indicators.

The definition of scenarios is conceived as a way to imagine and visualize the effects of different typologies of actions. As defined by the scenario theory, it is not possible to predict the future, but through an opportune scenario analysis it is possible to reflect about the consequence of actions that we implement today (Ogilvy & Scwartz, 2002). Even if the scenario analysis is normally applied

Figure 4 .1 <Nessun dato dal collegamento>



to market analysis and industrial design, the urban planning can also benefit from it (Secchi, 2003a)[4]. Hence, several studies on climate scenarios are available (EEA, 2017). For climate change prediction, scenario science is of fundamental importance in order to understand possible future impacts of climate change on Earth and on human society. Several approaches are actually existing both based on modelling and on scenario evaluations (EEA, 2017; O'Neill et al. 2014, 2015)[5].

The scenario analysis proposed into the GCC model is conducted on a double perspective: the definition of alternative scenarios until a preselected target and

4 "It seems to me that the guiding principle could be a continuous and patient construction of scenarios. "What would happen if..." - this is a scenario". (Secchi, 2003a, p. 3). Bernardo Secchi, in some recent papers, outlined the role that a scenario analysis can have into the definition of a more effective and deep reflection on urban transformation. As set by the same author, the use of a scenario analysis can also include non-experts groups into the reflection upon urban evolution. As the GC is defined as a process where there is a deep collaboration between different groups, behold the scenario proposition could become the way for visualising the discussion.

5 Climate change scenario science is of great interest in order to forecast impact on human society. However, this research didn't use them as they are still related to the large scale (not less than national). In further researches this part of the current debate could be deepen.

the definition of progressive time-bounded milestones[6]. As set by (Courtney, 2003) the scenario planning needs to be well-balanced and needs to answer to some important rules, for not coming up against unsatisfactory results or unmet expectations. At first it is important to understand why we are using a scenario instrument, defining if the aim is the long-term perspective or if there is a need of short-term actions. In both cases, the scenario planning could be useful on condition to clarify at first the typology of vision we want to achieve and the objective of this vision. Secondly, it is important to remember that scenario planning can help decision makers to "think outside the box" and to stress possible futures for a specified environment: scenarios are not planning instruments in the sense of giving sure answers or giving a real prediction of the future[7]. When these elements are clear, scenario planning can concretely help investigating the consequences of actions we want to improve in our environment (Courtney, 2003).

4.1.2 Addressing climate change: urban relience and built environment

As already set into previous chapters, the research aims at identify a model for addressing climate change mitigation and adaptation in urban built environment. Several specific problems can be described, but the research decided to start mainly focusing on two of them. As a consequence, this paragraph aims at outlining these challenges that have influenced KPI selection and scenario development: **resilience and built environment efficiency**. In fact, as defined by a number of authors, the resilience of a urban system and the energy efficiency of its built environment are two major problems of European cities (European Commission Directorate General, 2015; Santamouris, 2016; EEA, 2017). Considering the urban built environment, it is possible to operate a distinction: in fact resilience acts directly more on open space between buildings (e.g. streets, parks, gardens, etc.) while energy efficiency involve mainly the built environment in itself (buildings and infrastructures). Despite a spread presence of legislations and directives

6 "A vision is not a plan: it is, at the same time, a great deal less detailed and more complex; it does not define rights and specific duties, or construct executive procedures, but rather delineates a vanishing point, a horizon of meaning for an entire collectivity while specifying the appropriate strategies to reach it". (Secchi, 2002)

7 ''Vision-driven scenarios help management teams think ''outside the box'' and question their assumptions about the future. They are used primarily to generate new strategic options, facilitate learning and dialogue throughout an organization, and develop a shared commitment to the need for change."(Courtney, 2003, p. 14)

(see chapter 1) both at EU and national level, these two issues are still actual. By way of example, the total energy consumption of residential buildings in Europe increased by 14% between 1990 and 2012 (Santamouris, 2016) and electric consumption by 60%, mainly due to the diffusion on all society's levels of the electronic applications and devices. If we compare the consumption in tonnes of oil equivalent (ktoe) between 1990 and 2010, it is possible to underline how the challenge is complex and important: in fact in 1990 the EU consumed 273,384 ktoe, while, in 2010, 307,321 ktoe (Santamouris, 2016). Some projects' reports highlight how the increasing in energy consumption could be related to the increase of households' number in Europe (average 1% per year) but also to the modification of families structure, with a general reduction in the number of people living inside the same dwelling (Odysse-Mure, 2015; Santamouris, 2016). In fact the number of households with just one person has increased from the end of the 90's (OTB Research Institute for the Built Environment, 2010). Although the total amount of energy consumed is increased, it is important to notice that the energy required for thermal needs has decreased, thanks to new policies (see chapter 1). In particular, some studies record a decrease for thermal needs of about 15% (the considered period is 1997-2009) (Odysse-Mure, 2015; Santamouris, 2016). Conversely, the consumption for cooling is still increasing, mostly in the south part of Europe (+30% in Italy). This phenomenon is directly linked with the increase of heat during the summer, which is in turn linked with climate change and, in particular, with the Urban Heat Island effect. Some of the climate stresses due to resilience lack and energy un-efficiency are evidenced in table 4.1. Further details about climate change impacts on society are available in chapter 1.

4.2 Description of the model, data collection and KPI description

The model is composed by a steps-by-step structure involving a circular process, as shown in Figure 4.2. The five steps composing the model are desccribed as following:

- the first step is the analysis of the **state of the art** of the district. A set of 11 indicators is provided in order to achieve a first analysis of the existing situation into the selected district. The set of indicators, the normalisation methodology and the output of this phase are presented in the following paragraphs. This phase lead to the definition of a spider graph named "Preliminary analysis".
- The second phase involves the **definition of a specific target** (Directorate-

General for internal policies- European Parliament, 2014, p. 101). A checklist template is developed as a supporting instrument (see Attachments). In particular the following elements are included into the checklist:

- time horizon;
- energy and/or resilience final objectives;
- a number of milestones during the time horizon.

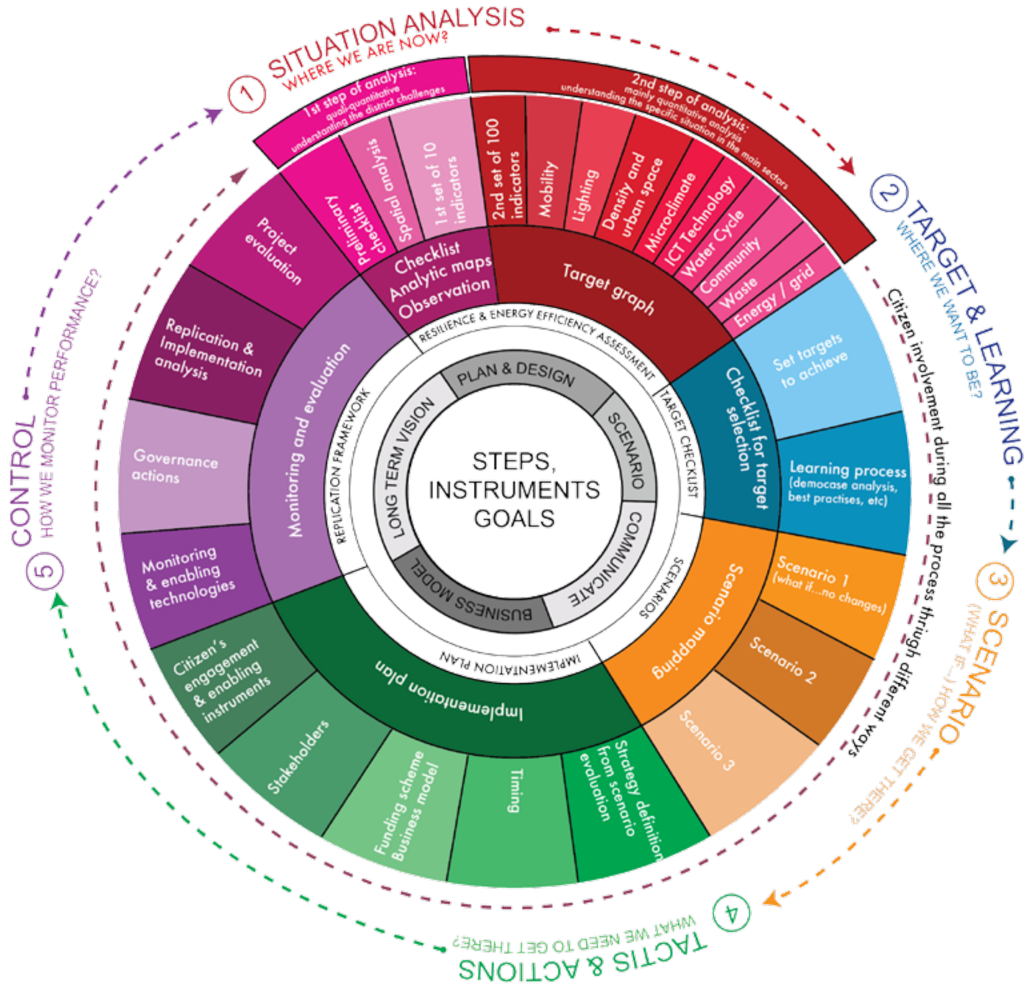
• The third phase analyses **alternative scenarios**. In particular, three scenarios are developed following these instructions:

- The first scenario reflects on the question "what if" no measures are implemented for mitigation or adaptation to climate change into the district object of the study. This is named "Scenario 0 - Business as Usual";

Table 4 . 1 Analysis of some effects due to lack of resilience and energy un-efficiency on the built environment

CHALLENGE	**EFFECT**	**DEFINITION**
Energy Un-Efficiency	Fuel poverty	Fuel poverty, is the inability of a group of people to pay for accessing energy (thermal, electric, fuel, etc.) (European Commission Directorate General, 2015; Fertner & Groth, 2015; GIZ & ICLEI, 2014; IPPC, 2014; Monfaredzadeh & Berardi, 2014; Wolfram, 2012; World Business Council for Sustainable Development, 2010).
Some effects on built environment: Fuel poverty can lead to several challenges on built environment: first of all healthcare problems and un-comfort conditions, then building maintenance, molds emergence and acceleration in the decay process of materials.		
Energy Un-Efficiency	Urban Heat Island (UHI)	"Under certain weather conditions a substantial difference in temperature may be observed between a city and its surrounding rural areas. When isotherms are drawn for the area in question, the city is apparent as a series of concentric, closed lines of higher temperature, with maximum values recorded at or near the densest part of the urban area. This condition in known as the urban heat island" (Erell, Pearlmutter, & Williamson, 2011)
Some effects on built environment: The presence of high temperatures during certain period of the year can cause important effects into the city: - first of all healthcare problems (specially on the weaker part of population, as children and elder) - increase of energy consumption for cooling; - raise of pollutant concentration into the air - deterioration of thermal comfort conditions (Santamouris, 2007; Santamouris et al., 2001)		
Absence of resilience	Rainfalls and floods	"With rainfalls, floods and drought it is generally intended the differences that seasonal and annual water balance has in respect with climate change" (Arnell, 1999). The difference that the water balance is recording in respect to the past, it is putting in trouble urban contexts. In particular, European cities are facing period of consistent rainfalls, creating flooding; as well as period of absence of rain, causing drought and water shortage.
Some effects on built environment: On the built environment perspective rainfalls and floods can lead to different un-efficiencies, such as traffic congestion, security and management problems, material decay and un-comfort.		

Figure 4 .2 The GCC model scheme



- The second and the third scenarios are alternative experimentations of application of mitigation and adaptation strategies.

• The forth phase sees the **definition of an implementation plan** composed by actions, participatory and involvement strategy, timing and business model.

• The last phase sees the definition of a **monitoring strategy**, for taking under control the project and for implementing changes if needed.

Steps are evaluated through the use of two groups of KPIs: the first group (11 key indicators) is the major one and it is usefull for addressing the main analysis of the selected context of application, while the second group (100 indicators) is aimed at deepen some specific parts and can be used on a flexible way. Indicators are aimed at describing the district as an organic system, underlying the mutual interrelation among buildings, infrastructures and open spaces.

Figure 4.3 shows the main outputs of each step of the process.

Next section described the selection of indicators.

4.2.1 Key performance indicators selection

The selection of indicators proposed into this section represent a physical, environmental and performance measurement of a complex system[8]. The aim is to reflect changes and key turning points over a period of time, for the selected problems of climate change and resilience applied to the district dimension. This goal is achieved by providing information about effectiveness and quality of the

8 The European Environment Agency (EEA) defines the nature of indicators (European Environment Agency, 1999). There are 4 typologies of indicators:

- Descriptive indicators. These sets describe the actual situation with regard to the main environmental issues. They answer the question: What is happening to the environment and to humans?

- Performance indicators. "They compare actual conditions with a specific set of reference conditions. They measure the 'distance' between the current environmental situation and the desired situation (target): 'distance to target' assessment. Performance indicators are relevant if specific groups or institutions may be held accountable for changes in environmental pressures or states." They answer to the question: Does it matter?

- Efficiency indicators. "Most relevant for policy-making are the indicators that relate environmental pressures to human activities. These indicators provide insight in the efficiency of products and processes. Efficiency in terms of the resources used, the emissions and waste generated per unit of desired output." They answer the question: Are we improving?

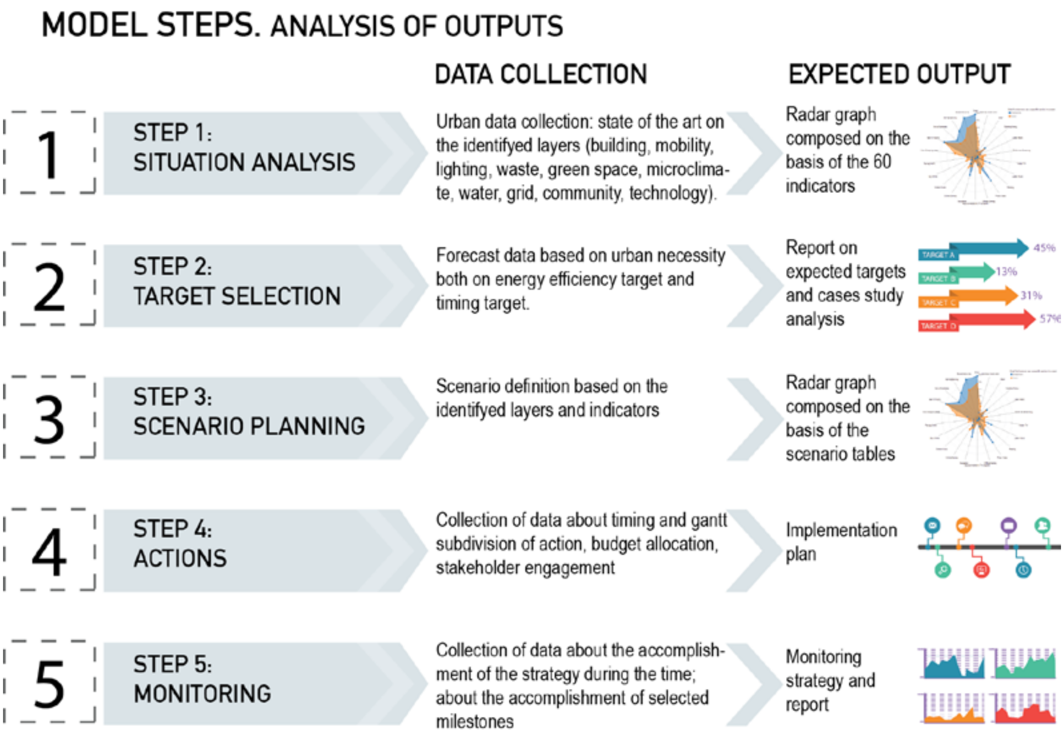
- Total welfare indicators. "Some measure of total sustainability is needed in order to answer this question, for example, a kind of 'Green GDP', such as the Index of Sustainable Economic Welfare (ISEW)." They answer the question: Are we on whole better off?

selected indicators, which they can draw attention to the effectiveness of current designing actions and policies (Hammond et al., 1995)[9]. The selection of indicator proposed into this study can be categorized under the definition of descriptive and performance. Descriptive because some indicators aim to analyse and describe the current situation; performance because some others aim to measure the distance from the actual situation to a target. The selection of indicators proposed into this study reflects the general aim of investigating and addressing two of the main urban challenges:

- energy efficiency of the built environment;
- resilience of districts.

The first analysis of the district is based on two complementary sets of

Figure 4.3 GCC outputs scheme related to steps



9 "Indicators are selected to provide information about the functioning of a specific system, for a specific purpose – to support decision-making and management. An indicator quantifies and aggregates data that can be measured and monitored to determine whether change is taking place. But in order to understand the process of change, the indicator needs to help decision-makers understand why change is taking place."

indicators[10]:

- the first main set of 11 indicators aiming at giving a general overview of the district and which are both of qualitative and quantitative nature[11][12];

- the second set of 100 indicators aiming at giving a more accurate and precise analysis of the district. They are divided in 10 sub-themes identified as elements where the district system (or organism) can be divided. It aims at understanding the specific state of the art in the 10 identified sectors and it can be used for deepening one of more specific sectors.

The two sets of indicators are complementary: the first one gives the overview of the districts' state of the art, the second one gives a more complete analysis of several sectors by which the urban system is composed. Table 4.2 records the first set of 11 KPIs and table 4.3 records the second set of 100 indicators.

---

10 The definition of indicator that the present research outlines is the European Environment Agency (EEA) definition: "Environmental indicators summarise, simplify and communicate more complex data sets: 'an environmental indicator is a measure, generally quantitative, that can be used to illustrate and communicate complex environmental phenomena simply, including trends and progress over time — and thus helps provide insight into the state of the environment".(EEA, 2005)

11 Quantitative indicators generally refers to indicators with a unit of measure or a numeric indication, such as a percentage, a ratio or similar (source). Qualitative indicators are those elements describing a phenomenon without giving a numeric quantification. Generally, a qualitative analysis is conducted through the use of surveys, or interviews and they aim to describe a complex situation with a number of interrelations that are not possible to describe with a percentage, a ratio, a number (Amaratunga, Baldry, Sarshar, & Newton, 2013) It is sometimes used in architecture and social sciences to understand lifestyles of people into a specific context or environment, to analyse what people feel about a subject, etc (Flick, 2014). As set by Uwe Flick "qualitative research is oriented towards analysing concrete cases in their temporal and local particularity and starting from people's expressions and activities in their local context". Into this research, with qualitative analysis, it is intended to analyse a complex phenomenon through a non-quantitative approach: in this case the district as a system. The ensemble of qualitative and quantitative analysis can give a complete analysis. The typologies of qualitative analysis used into this research are spatial analysis (hence through the use of geo-referenced maps or photographs), software analysis, participative observation and photography.

12 "Designing and implementing solutions requires a full and complete knowledge of the problem details, together with clearly defined qualitative and quantitative targets. Although the identified problems are global, they have different characteristics in different regions, societies and local communities. The capacity of the societies to implement proper policies may be determined by numerous factors, including the strength of the specific problems, the local economic conditions and the development prospects, the technological competence, the avail- ability of technological tools and also the economic and business models used." (Santamouris, 2016, p. 3)

Next paragraph (4.2.1) provides a specification and description of each indicator, with the definition of the normalization system.

The second set of indicators is a more complex analytic system aiming to evaluate on a deeper way several sectors of the urban system. There are 4 sections to which indicators are referred: 1) **built environment**, which comprises the physical part of the district (buildings, mobility infrastructures, etc.) 2) **natural environment and resources** regarding the natural resource usages into the district and the presence of green spaces and finally the 3) **social/digital environment** which comprises indicators about community, economy and ICT technology.

The sets of indicators are then divided into 10 main sub-categories:

- Buildings;
- Mobility infrastructure;
- Lighting system;
- Waste management;
- Urban density and green spaces;
- Urban microclimate;
- Water cycle assessment;
- Energy/grid;
- Community;
- ICT technology.

Each sub-category presents between 8 and 15 indicators, with a total of 100 indicators. Table 4.2 and 4.3 show the list of indicators including a brief description, unit of measurement and data source. The study decided to present indicators independently from data availability in the specific selected simulation case, studied in chapter 5. In fact, the un-availability of data is normalised as explained in the normalisation and weighting phase (see §4.4).

Description of indicators

Boxes from 4.2 to 4.12 explain in detail each indicator of the first set, defining the following elements:

- description;
- unit of measurement;
- calculation;
- impact on the design process;
- contribution to climate change mitigation and adaptation;
- references.

Table 4 . 2 First set of 11 indicators

ID	INDICATORS	UNITS	DATA SOURCE
1	Energy consumption of buildings	kWh/m^2y	Evaluation of energy consumption for thermal need for the average of buildings, divided into the main functions (residential, tertiary, enterprises, commercial). The data source can be the different depending on the energetic policies of the city. If present, it is the energy certification.
2	Percentage of renewable energy used for the built environment, on the total energy consumption (both electric and thermal).	%	A percentage of renewable energies on the total energy consumption is required. If the data are present, it is required a separated analysis of thermal energy and electric energy.
3	Buildings density and canyons geometry	m^2/km^2	The building density factor is calculated from m^2 of buildings on the total km^2 of the selected area. The calculation is based on a spatial analysis, on the basis of a geo map. The canyon geometry is a qualitative analysis of the main canyons geometry, in which are highlighted the sky view factor, the general geometry of buildings, the presence of vegetation and other relevant elements.
4	Anthropogenic heat	W	The source for anthropogenic heat, in this study, is given by a calculation based on the thermal conduction of building envelope.
5	Evapotranspiration ratio	%	The evapotranspiration ratio is calculated as a percentage of impervious surfaces on total selected area. Data come from a spatial analysis.
6	Thermal comfort	PMV index	The thermal comfort is the thermal perception of a group of people in a selected area.
7	Distribution of vegetation	qualitative	The distribution of vegetation is evaluated on the basis of a spatial analysis.
8	Air pollution	n°(d)	The air pollution is evaluated with the n° of days in which the presence of particulate is higher than the international limit. The data are provided by the municipality or by reports on air quality.
9	Green public transport penetration	qualitative	The penetration of public transports is conducted on the basis of a qualitative analysis based on a map of the district (spatial analysis).
10	Presence of ICT devices	qualitative	The presence of ICT systems (or more advanced ones) at the level of district microclimate assessment is considered in n° of systems into the whole district, with the specification of the use of these systems.
11	Innovative environment: presence of innovative technologies/services/participatory approaches at the district level	qualitative	The presence of particularly innovative instruments of climate change adaptation and mitigation (included on the social/educative level) are assessed through a qualitative analysis, giving an insight of the presence and a detailed description of such instruments.

Table 4 . 3 Second set of 100 indicators

SUB-CATEGORY	ID	INDICATORS	UNITS
Buildings	1	Presence of NZEB buildings or low-energy buildings or smart homes	n°
	2	Energetic requirement for heating and cooling	kWh/m^2y
	3	Electric requirements	kWh/m^2y
	4	% of energy requirements produced by renewables	%
	5	n° of buildings connected with smart grids or district energy systems	n°
	6	Embodied energy of buildings (average for typology)	$kgCO_{2e}$
	7	n° of buildings per typology (can be included in the previous indicator)	n°
	8	Presence of control units systems for energy management inside buildings (effective n°)	n°
	9	Presence of automated systems for energy management (effective n°)	n°
	10	Presence of intelligent facades (effective numbers / or savings)	n°
Mobility infrastructure	11	n° (or %) of public vehicles (for public transport of not) powered by RES or alternative energy systems	n°
	12	Distance radius from public transport stops to buildings	m
	13	Presence of public transport stops with information technologies	%
	14	Presence of intelligent parking and traffic systems (sensors and connection with platforms)	n°
	15	n° of collective parking giving access to multimodal mobility system	n°
	16	Availability of rechargeable stations for EV or EB	n° / km^2
	17	% of streets with reserved lane for bikes	%
	18	Presence of E-Bikes for public / touristic use	n°
	19	Pedestrian reserved areas	m^2
	20	Availability of mobility platforms (access to resident cards and discounts, or information)	yes/no
	21	Presence of intelligent traffic lights	n°
	22	Goods distribution systems with alternative vehicles	n°
Lighting system	23	Energy required for public lighting	kWh/pole
	24	n° of light poles	n°
	25	Led public lighting in respect to the total	%
	26	Energy required by LED lighting systems installed (if present)	kWh/pole
	27	Percentage of energy for public lighting coming from RES	%
	28	Incidence of light poles per metre of street	n°/m
	29	Hours of functionalities of light poles per day	h
	30	Light poles on bike lanes (if separated from other streets) and on pedestrian areas	n°/m
	31	Light poles on pedestrian areas / parks / etc	n° / m^2
	32	Presence of real time systems for lighting functionalities	yes/no
	33	Presence of multi-usage light poles (sensors, wifi repeaters, etc)	n°

Waste management	34	Presence of recycling system	yes/no
	35	Production of total waste per inhabitant	kg/inhabitant
	36	Production of recyclable waste per inhabitant on the total production	kg/inhabitant
	37	Efficiency of the recycling system (kg waste produced / kg waste recycled)	kg/kg
	38	Re-use of organic waste for greenings – presence of bio-digests (both for personal use ore for collective use)	n°
	39	Efficiency of bio-digests (kg organic waste produced / kg compost produced)	kg/kg
	40	Re-use of waste for energy production	yes/no
	41	Efficiency of this system (kg waste produced / kWh of energy produced)	kg/kWh
	42	Presence of intelligent systems for waste monitoring	yes/no
	43	Use of renewables for waste collection (transport) and treatment	yes/no
	44	Presence of collection islands for waste into the district	n°/km^2
	45	Distance radius of collection islands from residential areas	m
Urban density and green spaces	46	Floor density of the district (floor buildings area/total area)	m^2/ m^2
	47	Population density (n° of people / area)	n°/ m^2
	48	Percentage of square meters per inhabitants	%
	49	Presence of green spaces (total square meters of green spaces)	m^2
	50	Presence of qualitative green spaces (square meters of parks, or qualitative areas). Absolute (tot mq) and in relation with inhabitants (mq/inh)	m^2
	51	Qualitative green space per inhabitant	%
	52	Accessibility of qualitative green spaces from residential buildings (distance radius)	m
	53	Accessibility of qualitative green spaces from bike lanes and public transport network (distance radius)	m
	54	Incidence of trees on urban canyons (n° of trees per square metre of street)	n°/ m^2
	55	Incidence of green space on microclimate quality (calculation from reports on CO2 emissions)	CO_2
	56	Presence of productive green spaces (e.g. urban agriculture)	m^2
Urban microclimate	57	Air quality (presence of particular matter) OR transport related lead concentration in air	% (or µg/m^3)
	58	Days per year with low air quality	n°
	59	Air flows control systems	n°
	60	Sky-view factor control	%
	61	Walkability of streets	points
	62	Albedo control (on public surface and on buildings)	%
	63	Albedo control on buildings	%
	64	Average temperature range (min-max)	°C
	65	Days with too high temperature (related to benchmarking)	n°
	66	Days with too low temperature (related to benchmarking)	n°

	67	Presence of monitoring sensors for microclimate in general	n°
	68	Presence of systems for public communication of conditions (displays giving information)	n°/ km^2
	69	Presence of automated systems for microclimate reactions	yes/no
Water cycle assessment	70	Rainwater collection system	l/year
	71	Presence of a district recycling system for water	yes/no
	72	Presence of rain water collection on buildings (n° of buildings or units with water tank on the total buildings or units)	n°
	73	% of water recycled from rain collection (l of water collected/l of water re-used for community usages)	l/l
	74	Separation of potable water and non-potable water in buildings for different usages (e.g. all the water in buildings is potable or water for WC is non potable?)	n°
	75	Potable water consumption per inhabitants or unit (average)	l
	76	Evapotranspiration of urban surface (changes in evapotranspiration rates resulting from impervious surface ratio)	%
	77	Surface runoff (runoff based on the % of different types of surfaces)	%
	78	Efficiency of water distribution infrastructure (l of water emitted / l of water lost)	l/l
	79	Presence of monitoring system for infrastructure losses	n°
	80	Presence of monitoring systems inside units, for residential use	n°
Energy production (on a district dimension)	81	Presence of a smart grid	yes/no
	82	Presence of a district heating system	yes/no
	83	Presence of a district PV park (kWh/m2 of energy produced)	kWh/m^2
	84	Presence of district energy production systems (excluded PV park) (e.g. biomass, wind, etc.)	kWh/m^2
Community	85	Participation rate on public life (n° of people participating in open events) or social engagement	n°
	86	Presence of a sharing economy (on mobility, services, etc.) (calculation on the basis of surveys to citizens and on social media analysis)	n°
	87	Presence of a circular economy (e.g. solar communities or other experimentations)	yes/no
	88	Presence of fuel poverty (n° of people)	n°
	89	Technological readiness (n° of people that are not able to use technologies/total of people living in the district)	%
	90	Liveability of buildings (m2 per inhabitants)	m2
	91	Citizens associations into the district	n°
	92	Cultural activities / events organised in the district	n°
	93	Cultural services available in the district	n°
	94	Educative services available in the district	n°
	95	Creative labs or creative experiences / start ups in the district	n°
ICT Technology	96	WiFi /broadband coverage	n°
	97	Presence of e-gov platform or service platform	yes/no
	98	Presence of risk management technologies	yes/no
	99	Availability of open data	yes /no
	100	Presence of data mining companies/services that effectively mine all the data collected	yes/no

Box 4 . 1 Indicator 1

Indicator n° 1: Energy consumption of buildings
Description: Energy is required in buildings in order to explicit their functions. In particular, for heating and cooling, for lighting, cooking and for putting into operation a number of devices and instruments. The knowledge on energetic consumption (in term of electricity and thermal) is important in order to assess the state of the art of buildings in a selected area.
Unit of measurement: kWh/m^{2}y
Performance or descriptive indicator: performance. It is related to the main energetic classifications thresholds, given by the national legislation.
Calculation: The calculation of the building energetic needed for cooling and heating is a reflection of the efficiency of the building in itself, because it describes the energy needed for its functions. More the requirement is low and more the building is efficient, it has a low consumption and release less CO2 emissions, and influence less the over-heating of the microclimate around itself, as a consequence. In order to calculate this requirement, there is a specific legislation in all the different countries, explaining the methodologies. In particular, in Italy is named UNI TS 11300. In addition, different software based on the legislation are available for make easier this calculation.
Impact on design process: Buildings' energy consumption influences the use and depletion of resources, the air quality, the microclimate and the people comfort.
Contribution to climate change mitigation and adaptation: Low energy buildings can decrease the amount of energy and resources to be provided in a city, as well as contribute in an active and passive way to the reduction of GHG emissions and pollutants.
References: UNI TS 11300

Box 4 . 2 Indicator 2

Indicator n° 2: Percentage of renewable energy
Description: Renewable energies are nowadays widely spread into the built environment sector. This indicator aims to analyse how much the energy required by buildings is provided by renewable sources.
Unit of measurement: %
Performance or descriptive indicator: performance. It is related to the 2020 and 2050 EU targets.
Calculation: The calculation of the ratio of renewable energies present into the district is achieved through data provided by municipalities and it is based on the percentage of energy coming from renewables. If aggregated data are not available the calculation is conducted on the basis of an average: we consider as 100 the average kWh/m^{2}y of total energy consumption of buildings and the percentage is given by the RES percentage of energy provided (expressed in kWh/m^{2}y).
Impact on design process: The presence of renewables has a wide impact on the design process because it is necessary to better address the energetic needs of buildings. The implementation of these sources is important to decrease GHG emissions and to avoid the depletion of natural resources.
Contribution to climate change mitigation and adaptation: The implementation of renewables sources of energy influence climate change both in respect with mitigation and adaptation ways. In particular the use of renewable contributes to the mitigation of climate change because it provokes the diminution of GHG emissions and of resources' depletion. It contributes to the adaptation to climate change because it uses alternatives ways for providing energy.
References: 2020 and 2050 EU targets

Box 4 . 3 Indicator 4

Indicator n° 4: Anthropogenic heat
Description: The indicator evaluates the anthropogenic heat, which is defined as the amount of energy used for anthropogenic activities: i.e. transports, buildings, industrial activities, etc. In particular, it is set that the anthropogenic heat can be assessed by the evaluation of the three main components: vehicles, buildings and metabolism. Vehicles are responsible for heat coming from vehicular traffic; the buildings' heat comes from heating system, electricity, equipment; finally the metabolism is related to heat released by humans.
Unit of measurement: W
Performance or descriptive indicator: descriptive.
Calculation: The calculation can be conducted using with several methods. Considering that the present study may not address specifically the anthropogenic heat, estimation is sufficient for the purpose of the study: addressing as a whole the microclimate of a district. For these reasons, into the present study it is assessed the anthropogenic heat by considering heat conduction through building envelope. The related equation is the following: $$Q_f=UA\Delta T_{(i-e)}$$ Where, U is the thermal conductance of the buildings envelope; A is the surface area and $\Delta T_{(i-e)}$ is the difference in temperature between the internal and external surface of the building. This equation has several limits, but for the present study it could be sufficient.
Impact on design process: The assessment of anthropogenic heat is important in order to evaluate all the component of the outdoor energy balance. It is important because it gives the dimension of the heating passing through the envelopes of buildings, and give the idea of possible interventions that can be done in order to reduce it.
Contribution to climate change mitigation and adaptation: The anthropogenic heat is important as a component of a bigger analysis of the microclimate of a selected area, which is important to drive actions for mitigation and adaptation to climate change.
References: (Erell et al., 2011)

Box 4 . 4 Indicator 5

Indicator n° 5: Evapotranspiration ratio and impervious surface
Description: Evapotranspiration is a collective term for the transfer of water into the atmosphere from both vegetated and non-vegetated land surfaces. This indicator investigates the changes in evapotranspiration rates resulting from impervious surfaces.
Unit of measurement: %
Performance or descriptive indicator: descriptive
Calculation: The evapotranspiration rate (ER) is calculated as a percentage of impervious surfaces on the total selected area. The data come from a spatial analysis, as explained in the paragraph 3.2.X. The impervious surface ratio is calculated by dividing the total impervious surfaces in a parcel by the total parcel area, using the following equation: $$ER=(A_i\times 100)/A_{tot}$$ Where ER is the evapotranspiration rate; A_i is the impervious area on the total and A_{tot} is the total area considered.
Impact on design process: As a component of the hydrologic cycle, evapotranspiration protects and restores natural hydrology through vegetated surfaces. The implementation into the district of such surfaces can contribute to the mitigation of climate change and to the preservation of ecological balance.
Contribution to climate change mitigation and adaptation: Vegetated surfaces increase the rate of evapotranspiration, which contributes to cooling the air temperature by absorbing radiation and releasing water vapour. Furthermore, vegetation reduces the rainfall intensity by intercepting water temporarily on their canopy surfaces.
References: (Arnold & Gibbons, 1996; Dizdaroglu, 2013);Kittredge, 1973; Stewart, 1977; Mcpherson and Rowntree, 1993.

Box 4 . 5 Indicator 3

Indicator n° 3: Building density and canyons geometry

Description: The indicator aims to highlight the urban conformation of the district putting in evidence the density of buildings, the presence of public and open spaces, the presence of courtyards or tall buildings. In addition it aims to highlight the different canyon geometry present in the selected area.

Unit of measurement: m^3/m^2 + qualitative analysis through sections and maps

Performance or descriptive indicator: descriptive

Calculation: The calculation of buildings density is achieved by considering the cube meters of buildings footprint in respect of the whole square metres considered. The analysis of canyons geometry is conducted on each different canyon present into the district and it is done through the use of sections and qualitative analysis.
Two different analysis were done: a first quantitative one (with benchmark value) and a second qualitative one (with points assignment). The quantitative analysis is based on the canyon aspect ratio and the Sky View Factor evaluation, as highlighted in the following map:
Building density: calculated as m^3/m^2
Aspect ratio of street canyon: considering [H] canyon height, [W] canyon width and [L] the street's length; H/W and L/H define the geometry of canyon

H/W = 1 Regular canyon
H/W <0.5 Avenue canyon
H/W = 2 Deep Canyon
L/H =3 Short Canyon
L/H =5 Medium Canyon
L/H =7 Long Canyon

Sky Factor: calculated through the use of the software SkyHelios Model
The qualitative analysis is based on the assignment of points in presence of different elements. See the following table:

0,25 points	Presence of trees or vegetation
0,25 points	Presence of unimpeded sidewalk
0,25 points	Presence of bicycle path (separated from the vehicle one)
0,25 points	Simple access for all people (disabilities, elder, children)
0,25 points	Garbage (and other services) on sidewalks
0,25 points	Presence of street furniture (bench, etc)
0,25 points	Flux clear separation
0,25 points	Street lighting

The total gives 2 points as maximum.

Impact on design process: The density of buildings and their conformation, as well as the geometry of canyons is important to address any strategy and project. In particular it affects the evaluation and addressing of microclimate.

Contribution to climate change mitigation and adaptation: The building density and, overall, the canyons geometry contribute to climate change adaptation because the physical conformation of streets can adapt the natural captation of resources (radiation, rainfall, etc…). In addition, a good physical conformation can mitigate the overheating of streets, increasing the urban comfort.

References: (Erell et al., 2011; Guite, Clark, & Ackrill, 2006; Nunez & Oke, 1977; O'Campo, Salmon, & Burke, 2009; Vardoulakis, Fisher, Pericleous, & Gonzalez-Flesca, 2003)

Box 4 . 6 Indicator 6

Indicator n° 6: PMV – Thermal comfort
Description: The thermal comfort is the thermal perception of a group of people in a selected area.
Unit of measurement: PMV index
Performance or descriptive indicator: Thermal comfort is determined by the index PMV (Predictive Mean Vote) and predicts the mean thermal sensation voted on a standard scale from a large group of persons. The American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE) developed the thermal comfort index by using the coding: -3 for cold, -2 for cool,-1 for slightly cool, 0 for natural, +1 for slightly warm, +2 for warm, and +3 for hot. PMV index has been adopted by the ISO 7730 standard.
Calculation: The analysis of thermal sensation is complementary to the microclimate analysis of an urban area because it gives the impressions of people living and passing in that area about their comfort. The analysis is conducted with the use of the PMV index. PMV is calculated by Fanger's equation with the support of the Envi-met simulation tool.
Impact on design process: The personal comfort has an important impact on the design process because it gives a precise idea of what people fell in a space.
Contribution to climate change mitigation and adaptation: -
References: (Chen, Jiao, & Lee, 2006; Dounis & Caraiscos, 2009; Erell et al., 2011; Fanger, 1972; Matzarakis et al., 2007)

Box 4 . 7 Indicator 7

Indicator n° 7: Distribution of vegetation
Description: The distribution of vegetation is the qualitative analysis of the way in which vegetation is located into the district. It is proved by several authors, that in order to be more effective, the vegetation must be continuous or placed in groups.
Unit of measurement: qualitative
Performance or descriptive indicator: descriptive
Calculation: The analysis of vegetation is qualitative and conducted on the basis of sections and plans.
Impact on design process: The vegetation has important impacts on the design process because within the use of green areas it is possible to mitigate climate change.
Contribution to climate change mitigation and adaptation: The vegetation contributes to climate change in direct and indirect ways. In fact it influences several aspects: the give additional shadow, evap-otranspiration surface, non-impervious surface that have a direct influence on the microclimate. They can mitigate air pollution. In addition, they can be used as rain-tanks or elements to decelerate water runoff.
References: (Erell et al., 2011)

Box 4 . 8 Indicator 9

Indicator n° 9: Green public transport penetration
Description: The public transport penetration analyse in a qualitative way the presence of green public transport into the selected district.
Unit of measurement: qualitative and comparison with the normal public transport (potentialities)
Performance or descriptive indicator: descriptive
Calculation: The analysis of public transport is qualitative and conducted on the basis of maps. Two layers will be evaluated: the first one is the green public transport penetration, while the second layer is the normal public transport penetration, which gives the dimension of potentialities.
Impact on design process: The public transport has important impacts on the design process both on public comfort and accessibility to the area, as well as for climate issues.
Contribution to climate change mitigation and adaptation: The transport contributes to climate change in a direct way. In fact it influences air pollution, the over-heating of the district, but it increase the pos-sibility of using the public transport meanings instead of personal cars.
References: (Erell et al., 2011)

Box 4 . 9 Indicator 8

Indicator n° 8: Air pollution
Description: The air pollution indicator highlights the number of days in which the amount of particulate is exceeding the benchmark value defined by international protocols. In particular, the benchmark value considered into this research is the protocol of Gothenburg.
Unit of measurement: n° of days
Performance or descriptive indicator: performance. It is related to the Gothenburg protocol and to the National Emission Ceilings Directive (NEC Directive).
Calculation: The calculation is normally conducted by municipalities, and it is included into reports and statistics about the air quality of the city. If there is the possibility to monitor in real time the air pollution, it is preferable to use these data.
Impact on design process: The n° of days with an exceeding of particulate matter in the air is important to address specific strategies into a district.
Contribution to climate change mitigation and adaptation: Air pollution has several effects on climate change. Particle pollution can have significant impacts on climate, both directly and indirectly. The direct effects come from particles' ability to absorb and scatter light. Particle pollution can also have important indirect effects on climate. For example, particles can change the reflectivity of clouds and also indirectly influence cloud lifetime and precipitation. The knowledge about this data is important to better address the actions to implement for contribute to the mitigation and adaptation to climate change.
References: (EPA, 2011; Erell et al., 2011)

Box 4 . 10 Indicator 10

Indicator n° 10: Presence of ICT devices
Description: The indicators 10 defines the presence of ICT devices aiming to increase the knowledge both for the built environment energy consumption and the microclimate conditions, as well as to increase automatic response to specific data occurrence.
Unit of measurement: presence of devices into the area
Performance or descriptive indicator: descriptive
Calculation: The data are provided by the municipality and by the energy provider or by the direct observation.
Impact on design process: The installation of ICT devices need to be preventively planned inside the design process in order to gain effective and usefull data.
Contribution to climate change mitigation and adaptation: The contribution to climate change mitigation and adaptation is dependent to the specific device installed. However, an increased knowledge district performance can lead to actions having direct impacts on climate.
References: -

Box 4 . 11Indicator 11

Indicator n° 11: Innovative environment
Description: The indicators 11 defines the presence of an innovative environment inside the context.
Unit of measurement: qualitative
Performance or descriptive indicator: descriptive
Calculation: The data are provided by the municipality and by the direct observation.
Impact on design process: -
Contribution to climate change mitigation and adaptation:
References: (Bonomi, Masiero, 2015)

Omitted indicators

Some important indicators mainly related to social and economic structure of the urban environment are omitted. The reason is that the GCC model includes only relevant indicators having a direct or proved contribution to climate change mitigation or adaptation, or they have a direct influence into the calculation of other indicators having these characteristics. In the table below, are resumed the main omitted indicators.

Omitted indicators for the sub-category of Demography (1) Population age; (2) Immigration status (3) Social stratification (4) Gentrification
Description: There are several studies, such as those of Martin et al. 2004; Grove et al. 2006, Luck 2007, trying to show the relations between climate change actions and effectiveness with population age and composition. Such indicators are however fundamental in order to achieve a deep knowledge into the urban context in which policy makers operate. In addition they are important to address an holistic design strategy for example in the field of propensity to improve technological buildings, or in term of security implementation or in term of presence of services. Also social stratification can become important on the diffusion of climate education and attention. In particular, for example, there are interesting studies which put in relation family incomes with the access to energy supplies, with gentrification due to urban modifications and with social movements. Even if those studies are interesting, the research decided to do not consider them as centre of the discussion, postponing to future researches their analysis and inclusion inside the model.

Omitted indicators for the sub-category of Urbanism (5) Land use; (6) district position; (7) land load (expressed in m^3/m^2)
Description: Several indicators affering the category of Urbanism have not been considered inside the model. However some are considering into the first step of the model, inside the preliminary analysis (see related section).

Omitted indicators for the sub-category of Technology of Architecture
Description: Inside the sub-category of Technology of Architecture different indicators have not been considered. In particular all indicators affering materials have not been included into the model (except those affecting albedo). Even if some indicators are important for defining district quality, in term of thermal performances, physical quality and aspects, hygrometric performances, etc., only few indicatos have been included inside the calculation of Thermal Comfort and Anthropogenic Heat (see box 4 and box 6). In future development of the research, more indicators will eventually added and considered.

Omitted indicators for the sub-category of Electrical and Digital Technologies
Description: Inside the sub-category of Electrical and Digital Technologies different indicators have not been considered. In particular all indicators affering smart grids (network and specific appliances), domotic and other technologies. In future development of the research, more indicators will eventually added and considered.

4.2.2 Data collection and analysis

This section introduces KPIs from the point of view of data collection, analysis and normalisation.

As the indicators are not referred to a parcel or to a unique building but to a composite group of buildings and infrastructures, the data collection is conducted on the basis of an aggregate way. In particular, when possible, data are collected as unique elements (e.g. indicators about green spaces or services, etc.) conversely when not possible, they are collected as average on the basis of report analysis.

As each indicator has different measurements units, which cannot be compared to each other or visualised on an effective way, a normalisation of these data is needed. The benchmarking normalisation method is employed to remove the scale effects of these different units by standardising the original indicator units to normalised units (Nardo, Saisana, Saltelli, & Tarantola, 2005). The selection of this method is conducted after the analysis of several studies, and into this study, it is developed considering the following elements, depending on the nature of the indicator in itself:

- effects of the indicator on mitigation and adaptation on climate change;
- effects of the indicator on the accomplishment of national/EU targets;
- presence of a benchmark defined by a specific legislation.

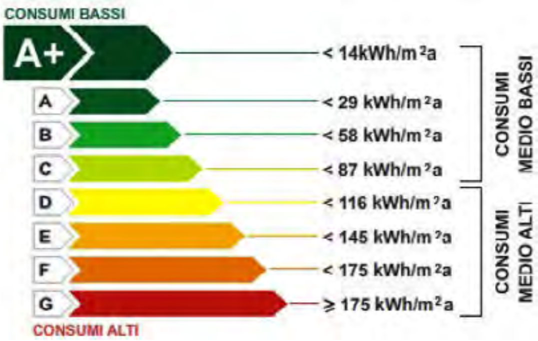
Each indicator is expressed with a value between 1 and 5 indicating different levels of sustainability. Table 4.4 represents the definition of these five reference levels.

The normalisation of indicators and the assignment of points aiming to give an output, which is comparative, is conducted only for the first set of indicators as the first set is conceived as the major one in term of results and usability, while the second one is planned to be used for investigating in a more accurately way some specific sectors. The boxes below explain the benchmark values considered, and the assignment of points.

Table 4 . 4 Point assignment reference table

5	HIGH	Target level of sustainability
4	MEDIUM-HIGH	Satisfactory level of sustainability, on road to reach the target
3	MEDIUM	Discrete level of sustainability / legislation level
2	MEDIUM-LOW	Not sustainable / Under the legislation level
1	LOW	Completely unsustainable / non sufficient level
0	NO DATA	The data are still not available for this indicator. There is a need to increase the knowledge on this aspect

Indicator n° 1: Energy consumption of buildings
Unit of measurement: kWh/m^{2}y
Benchmark values: The parameters of this indicator were derived from the Italian APE legislation. The points were assigned on the basis of the average energy consumption of the buildings.



Point assignment table:

Value of energetic needs	Benchmark Value	Rate
< 14 kWh/m2y	HIGH	5
15 < x < 50 kWh/m2y	MEDIUM-HIGH	4
51< x < 100 kWh/m2y	MEDIUM	3
101< x < 200 kWh/m2y	MEDIUM-LOW	2
> 200 kWh/m2y	LOW	1
no data available on this indicator	NO DATA	0

Indicator n° 2: Percentage of renewable energy used for the built environment, on the total energy consumption
Unit of measurement: %
Benchmark values: The parameters are derived from the European target to 2050, in the last version available. In particular, the EU set to reach the reduction of 20% of GHG and have 20% of renewables before 2020. Before 2050, it is set the target of 80%. The rate is based on these targets.
Point assignment table:

Value of energetic needs	Benchmark Value	Rate
100%	HIGH	5
80%	MEDIUM-HIGH	4
50%	MEDIUM	3
20%	MEDIUM-LOW	2
< 19%	LOW	1
no data available on this indicator	NO DATA	0

Indicator n° 3: Building density and street canyons

Unit of measurement: m^2/km^2 and qualitative analysis

Benchmark values: The parameters are derived from different studies making a relation between physical space and people well-being (Guite et al., 2006; Nunez & Oke, 1977; O'Campo et al., 2009; Vardoulakis et al., 2003)

Point assignment table:

a) Geometry streets canyons is evaluated with the table below:

Canyon geometry (CG)	Benchmark Value	Rate
<0.5	Avenue canyon	3
0.5 < CG < 1.9	Regular canyon	2
> 1.9	Deep canyon	1
no data available on this indicator	NO DATA	0

b) For the Sky View Factor the following table is used:

Values of Sky View Factor	Benchmark Value	Rate
1,0	HIGH	5
0,5<SVF<1,0	MEDIUM-HIGH	4
0,5	MEDIUM	3
0,0<SVF<0,5	MEDIUM-LOW	2
0,0	LOW	1
no data available on this indicator	NO DATA	0

c) For the qualitative analysis 0,25 points are assigned per each of the following element presents:

0,50 points	Presence of trees or vegetation
0,50 points	Presence of continuous green surfaces (e.g. flower beds, surface along streets, etc.) for more than 50 m or 10 m2
0,25 points	Presence of unimpeded sidewalk
0,25 points	Presence of bicycle path (separated from the vehicle one)
0,25 points	Simple access for all people (disabilities, elder, children)
0,25 points	Garbage (and other services) on sidewalks each 200 m
0,25 points	Presence of street furniture (bench, etc) each 200 m
0,25 points	Flux clear separation
0,25 points	Street lighting

The maximum of additional points is 3,5 , and the total rate cannot exceed 5.

The total is given with the sum of total point for each table.

Indicator n° 4: Anthropogenic heat
Unit of measurement: W/m^2
Benchmark values: The parameters of this indicator were derived from the Italian legislation on wall limit transmittance. The value of AH is calculated using difference wall transmittances and a fixe from inside to outside of 15 K and a surface fixed at 1 m^2.
Point assignment table:

U wall	AH (W/m2)	Rate
<0,24 W/m2K	< 3,6 W/m2	5
0,24 < U wall < 0,30	3,7 < W/m2 < 4,4	4
0,30 < U wall < 0,37	4,5 < W/m2 < 5,5	3
0,37 < U wall < 0,6	5,6 < W/m2 < 8,9	2
> 0,6	> 9 W/m2	1
no data available on this indicator	no data available	0

Indicator n° 5: Evapotranspiration and Impervious Surface Ration
Unit of measurement: %
Benchmark values: The parameters of this indicator were derived from the literature review.
Point assignment table:

Evapotranspiration	Impervious Surface	Benchmark Value	Rate
40 %	0 (natural ground cover)	HIGH	5
39%	1-15	MEDIUM-HIGH	4
37%	16-43	MEDIUM	3
33%	44-88	MEDIUM-LOW	2
30%	89-100	LOW	1
no data available on this indicator	no data available on this indicator	NO DATA	0

Indicator n° 6: PMV – Thermal comfort
Unit of measurement: PMV
Benchmark values: The parameters of this indicator were derived from the literature review.
Point assignment table:

PMV Value	Benchmark Value	Rate
0	HIGH	5
-1; +1	MEDIUM-HIGH	4
-2 ; +2	MEDIUM	3
-3 ; +3	MEDIUM-LOW	2
-4 ; +4	LOW	1
no data available on this indicator	NO DATA	0

Indicator n° 7: Distribution of vegetation
Unit of measurement: qualitative
Benchmark values: The parameters of this indicator were derived from the literature review.
Point assignment table:
The rate is assigned with the sum of points, following the table below. The maximum of points assignable is 5.

Points	Description
2	More than 50% of streets have linear trees distribution
1	More than 50% of streets have single trees distribution (non linear or distance more than 1 km to each other)
3	More than 50% of open spaces have wooden trees distribution
1	Less than 50% of streets have trees
1	Less than 50% of open spaces have trees
0	NO DATA

Indicator n° 8: Air pollution
Unit of measurement: different data
Benchmark values: The parameters of this indicator were derived from the literature review.
Point assignment table:
The EU assigned some standards parameters for air quality (European Parliament & Council of the European Union, 2008). The benchmark values are listed in the table below:

Particle	Standard values	Permitted exceedences each year
PM 2.5	25 μg/m^3 (1 year)	n/a
Sulphur Dioxide SO2	350 μg/m^3 (1 hour)	24
	125 μg/m^3 (24 hour)	3
Nitrogen dioxide NO2	200 μg/m^3 (1 hour)	18
	40 μg/m^3 (1 year)	n/a
PM 10	50 μg/m^3 (24 hours)	35
	40 μg/m^3 (1 year)	n/a
Lead Pb	0.5 μg/m^3 (1 year)	n/a
Carbon monoxid CO	10 mg/m^3 (8 hour)	n/a
Benzene	5 mg/m^3 (1 year)	n/a
Ozone	120 μg/m^3 (8 hour)	25 days averaged over 3 year
Arsenic As	6 ng/ m^3 (1 year)	n/a
Cadmium Cd	5 ng/ m^3 (1 year)	n/a
Nickel Ni	20 ng/ m^3 (1 year)	n/a
Polycycic Aromatic Hydrocarbons	1 ng/ m^3 (1 year)	n/a

Points are assigned on the basis of the respect of standard value per each element present in the table below. In particular, 0,41 points are assigned per each respected value.

Indicator n° 9: Green public transport penetration	
Unit of measurement: m	
Benchmark values: The parameters of this indicator were derived from the literature review.	
Point assignment table:	
Points are assigned on the basis of the table below. The rate is given by the sum of the assigned points, with a maximum of 5.	

Points	Description
1	radius distance among buildings and bus stops (with alternative/green vehicles) <200 m
1	radius distance among buildings and multimodal parking <500 m
1	radius distance among buildings EV charging stations (with alternative/green vehicles use) >200 m
1	Presence of parks for bike sharing or car sharing
1	Presence of parks with permeable surface
1	radius distance among buildings and normal bus stops <200 m
0	radius distance among buildings and public transport facilities > 500 m
0	NO DATA

Indicator n° 10: Presence of ICT devices	
Unit of measurement: n° of devices and presence	
Benchmark values: The parameters of this indicator were derived from the literature review.	
Point assignment table:	
Points are assigned on the basis of the table below. The rate is given by the sum of the assigned points, with a maximum of 5.	

Points	Description
2	Presence of an integrated strategy at the district level assessing the project of ICT devices and open data strategies
1	Presence of monitoring devices (air quality, flooding, microclimate, traffic, parking, etc.)
1	Presence of automated devices able to act in reaction of collected data (smart traffic lights, smart parking information, smart traffic jam info, etc.)
1	Presence of energy management systems at the built environment level (e.g. NEST) or at the district level
1	Presence of intelligent façades
0	NO DATA

Indicator n° 11: Innovative environment
Unit of measurement: presence
Benchmark values: The parameters of this indicator were derived from the literature review.
Point assignment table:
Points are assigned on the basis of the table below. The rate is given by the sum of the assigned points, with a maximum of 5.

Points	Description
2	Presence of an integrated strategy at the district level for increasing innovation, increasing the presence of living labs, etc.
1	Presence of living labs
1	Presence of start ups or artists
1	Presence of associations active on the community and the urban environment
2	Presence participative approaches both bottom up and top down
0	NO DATA

4.3 Step-by-step approach and usability of the tool

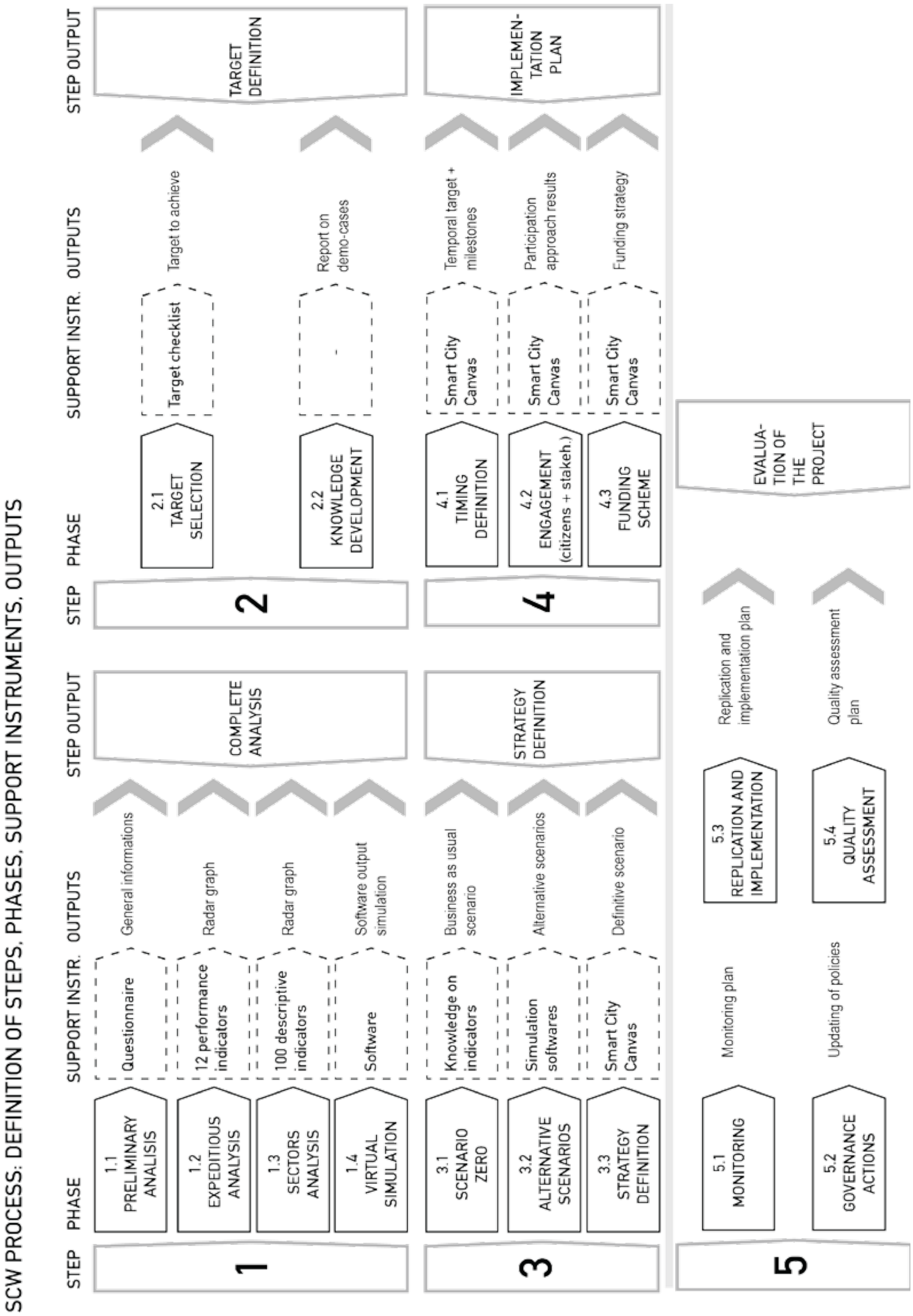
After having described the methodology subtended into the model, the following section addresses in a specific way each step of the process, describing precisely the input data needed, the objectives, the materials that can be used as instruments and the expected outputs for each part of the model. For each step a summary table is provided at the beginning of each paragraph. The model is divided into 5 major steps, each of them having a specific function. All together they contribute to the formation of a smart process, where the design phase is addressed on the basis of a complete qualitative and quantitative analysis. The Figure 4.4 evidences the structure of the process.

Step 1: analysis of the district

The first preliminary analysis is conducted trying to investigate what are the main challenges into the selected district, by using different approaches:

- analysis of reports, studies and publication specifically related to the selected district (if present), with the aim to show the constraints of the area, both on climate and social perspective
- analysis of guidelines for the district
- analysis of relation between the selected district and other urban policies
- urban and social analysis of the district (position in relation with the rest of the city, mobility, social analysis, potentialities, etc)
- analysis through the use of a participative observation approach in order to

Figure 4 .4 Outline of each process steps



Phases OF STEP 1	Support instruments	Expected output
Preliminary analysis: this analysis aims to highlight the general issues of the district with the description of the general information about the district	Checklist (see appendix X)	General information about the district
Phase 2: Assessment of resilience and energy efficiency through a expeditious analysis	1st set of 12 indicators	Radar graph from the expeditious analysis and a series of qualitative maps and sections
Phase 3 (optional): Assessment of resilience and energy efficiency through a deep analysis of each sector	2nd set of 100 indicators	Radar graph for each sector (possibility to choose on which sector -or selection of sectors- focus more)
Phase 4 (optional): Additional assessment of the microclimate with the virtual simulation with software (Envimet and eventually RayMan model)	Software	Software calculation
Output of the step 1:		
- Deep analysis of the district from the point of view of resilience, energy efficiency and other general issues (demography, population, events, etc). - Preliminary identification of the main sectors of intervention or the sectors with the major problems.		

gain an insight on people behaviour and wishes (see Annex II.1 , p. 334).

A checklist, named Preliminary Checklist, is provided inside the Attachments (p. 320) for supporting this phase. Then, phase 2 and 3 foresees a specific analysis based on indicators (phase 3 is optional) while phase 4 (also optional) gives an insight on microclimate conditions. The expected output of Step 1 is a first spider graph based on the main set of 11 indicators and a qualitative analysis on the selected district.

Phases of step 2	Support instruments	Expected output
Target selection: the target selection is conducted through the identification of qualitative and quantitative targets (i.e. percentage of efficiency, resilience targets, improvement of a specific sector, etc).	Target checklist	Target to be achieved
Knowledge development: On the basis of the target selected it is important to improve the knowledge of other districts or urban context. This part is important to learn the positive and negative actions, and the expected benefits.	-	Report on case studies
Output of the step 2:		
- Definition of quantitative and qualitative targets to be addressed by the design process		

Step 2: target selection and development of related knowledge

Step 2 is based on knowledge development and target selection. In order to understand which targets are the most urgent a provided checklist can be used. Inside the checklist, named Target checklist (p. 323) it is possible to choose among a set of common targets: resilience, energy efficiency, social aspects, etc. One of the most important key of success is to define a quantitative target to be achieved on a specific timing perspective.

The knowledge development is expected to be achieved contextual with the target selection of after it. In fact, several best practises and case studies can be found in dependence of the major target that each territory have.

Step 3: scenario planning and vision selection

Phases of step 3	Support instruments	Expected output
Scenario 0: the first scenario to be developed is the hypothesis of non-implementing actions or adaptation and mitigation measures. In other term is the scenario answering the question: What would happen if no actions were activated? (Business-as-usual scenario)	Knowledge from other cities experience Knowledge on the district challenges and data	Business-as-usual scenario
Alternative scenarios 1 and 2: development of two additional alternative scenarios. The strategy is to focus on those elements able to engender a positive effect. In other term the strategy is to investigate what kind of actions can produce more effects over a period of time.	Simulation Software Knowledge from literature review on specific indicators	Alternative scenario 1 and 2
Definition of the strategy: after the research of alternatives, it is possible to select or compose a new scenario, aiming to put together the best solutions investigated	Previous scenario	General strategy definition
Output of the step 3:		
- Definition of the general strategy to be implemented		

Step 3 involves the development of three phases: definition of Scenario 0 (called also Business as usual); definition of alternative scenarios (from 2 to 5) and definition of a strategy to be implemented. All scenarios can be developed by using the 11 KPIs set, as a first image of the district. The second set of 100 indicators can be then used, if some specific governance areas need deep analysis. Scenario 0 is defined considering what would happen if, in the selected district, nothing is done. Some indicators can be quite precisely defined, by using climate change data (e.g. such as +2°C in average temperature). Other indicators can be calculated as reasonable average or by using climate change model simulations (O'Neill et al. 2014, 2015). However, scenario 1 to 5 (but it is considered better to draw no more than 3 alternative scenarios) can be calculated in respect with planned actions. In the simulation of the model inside the Bolognina district (see chapter 5) two alternative scenarios have been provided: the first one considered the application of actions only on buildings (for mainly address energy efficiency) while the second one considered the application of actions only on public space (for mainly address resilience). After the definition of scenarios it is possible to compare solutions through the visualization on spider graphs and finally to select a set of actions. In the simulation provided in chapter 5, the research decided to select mixed actions coming from both scenarios, chosen for their potential in triggering positive circles.

Step 4: implementation plan

Phases of step 4	**Support instruments**	**Expected output**
Timing definition: definition of the temporal target with the different milestones	-	Temporal target and milestones
Citizen and stakeholder engagement: involvement of citizens and stakeholders	-	Participation approach results
Funding scheme: definition of the general funding scheme/ funding strategy of the project	-	Funding strategy
Output of the step 4:		
- Implementation plan		

Step 4 can be considered one of the most important planning part, as it involves the definition of the implementation plan, with timing approach, rbusiness model and stakeholder engagement. The involvement of citizens and stakeholder can also start during the scenario analysis part (step 3) or even during the target selection (step 2). The model is, in fact, conceived as a flexible structure. An implementation plan is expected to come out from this step.

Step 5: monitoring phase

Step 5 is the monitoring and evaluation phase. It is important at the end of the project and after implementation of action, evaluate ongoing project and, where necessary, re-start the process or modify some actions. For being ready to analyse results of the whole strategy, it is necessary to foresee monitoring actions and an evaluation plan composed for example by deadlines and milestones. Also replication and scaling-up can be foresee into this section, if necessary.

In next chapter a simulation of the model inside Bolognina district, in Bologna, is provided.

Phases of step 5	Support instruments	Expected output
Monitoring: definition of the monitoring strategy, (if applicable) of the ICT technologies to be implemented for monitoring purpose, and control on the effective monitoring actions	-	Monitoring plan
Governance actions: definition, if necessary, of the governance actions to be implemented (updating policies, legislations, implement incentives, etc)	-	Updating of policies, legislations, etc
Replication and implementation: definition of the replication and implementation strategy	-	Definition of the replication strategy
Project evaluation: final project evaluation	-	Evaluation and quality assessment plan
Output of the step 5:		
- Quality and monitoring plan - Evaluation of the project - Implementation strategy both in other districts and in other cities		

5 Bolognina neighbourhood. Simulation of the Green City Circle

After having analysed the current theoretical contribution about the SC topic, highlighted current definition (see chapter 1); after having analysed key factors and key indicators (see chapter 2); and finally having proposed a model where a specific process is described for implementing smart and green cities (see chapter 3), into this chapter, an example on how this model can be applied to a real context is provided. Nevertheless this chapter doesn't intend to be a real validation of the model, because the process was not really applied but simulated into a selected context.

As a consequence, the aim of this chapter is to provide a simulation of the proposed GCC. The chapter aims, as a complementary point, to understand how the model works when applied and if there are some adjustments or modifications needed.

This chapter is structured in two parts: the first one gives an insight on the selected context, describing: 1) the city of Bologna, with urban instruments currently available and on-going projects; 2) the Bolognina district as a pilot.

The sources used into the chapter to achieve the aim are the following: i) the model proposed into chapter 4, which gives also the structure of paragraphs; ii) cases study similar to the Bolognina district; iii) literature based on processes, monitoring and evaluation; iv) researches about scenarios; v) Bologna reports and framework documents. Some more sources are European guidelines for European projects (e.g. for implementation plan, risk analysis, etc).

The research questions to which the chapter aims to answer are the following:

- how the model works when really applied into a context?
- what are the successful and the weak points of the model?
- what are the effective results that the model gives at the end of the process? Are they useful for addressing strategies?

5.1 Bolognina district as a resilient urban cell

This paragraph describes the environment where the GCC is applied. It highlights in specific the following elements:

- the city of Bologna with main strategies and some interesting on-going projects;
- the district of Bolognina.

The aim of the paragraph is to put in evidence main aspects making the city of Bologna an interesting environment for testing piloting solutions. In particular policies, projects and plans are described.

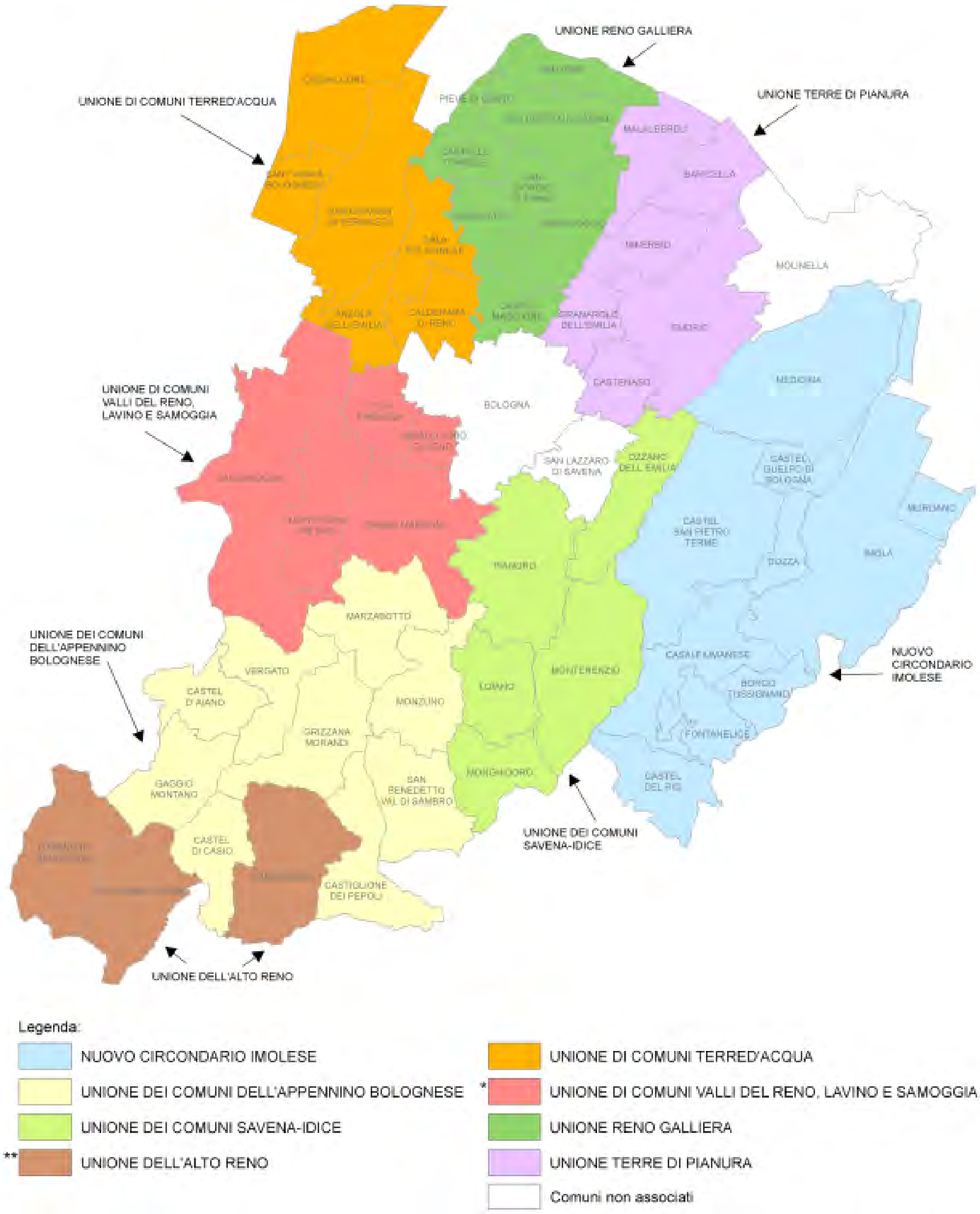
5.1.1 An overview of the metropolitan area: shared vision toward 2050

Bologna, the capital of Regione Emilia-Romagna, is the 7th most populous Italian city (386,298 inhabitants, with a density of 2,742.43 inh./m^2), with a metropolitan area of about 1 million inhabitants. The city has a significant endowment of transport infrastructure (airport, train station and the new high-speed AV rails, the intersection of three highways), it hosts the oldest university of the west world and one of the largest in Europe (80,000 students) and it ranks among the top 10 (out of 100) Italian cities for income.

Bologna is one of the first cities in Italy implementing a debate about the metropolitan governance since the 70's. In fact, in those years they developed the PIC (Piano Intercomunale del Comprensorio = Territory Intermunicipal Plan), considering the territory surrounding the city as an important party of the governance. In fact, the city of Bologna was always been a centralizing pole for commerce, education and work in general. With the Law 142/1990, the consequent Regional Law 33/1995 and the final 2006 Framework Agreement of Metropolitan Cities, Bologna officially becomes a Metropolitan City.

Today the Metropolitan City of Bologna comprises 55 municipalities, with a

Figure 5.1 The Bologna Metropolitan city: confederations and unions



total territorial extension of 3.702,3 km^2 and an average density of 271,9 inh./km^2[1]. The major part of the 55 municipalities is associated in Unions or Federations (Fig. 5.1)[2].

1 Data are taken from the official website and documents. Available at: http://www.cittametropolitana.bo.it/portale/Engine/RAServePG.php/P/255810010406/T/Il-territorio

2 Note that when the expression "city of Bologna" is used, it is meant the municipal context of the city, while when it is used the expression "metropolitan city of Bologna" it is meant the complex metropolitan area. See the Figure 5.1 for visualizing this difference.

Inside the Metropolitan area, there are more than 1 million of people (of which 483,674 men and 522,157 women). The 11.6% (of the total) are inhabitants with a foreign citizenship (of which 53,403 men and 63,719 women) (2016 data). Inside this context, there is a big social mobility, followed by an extended mobility infrastructure. In fact, statistics confirm that more than 220,000 persons come inside the Bologna context for education or work reasons each day. In particular, about 76,000 people every day come into the city centre. The city can be described and presented focusing on main aspects[3]:

- **Position, environment and energy**. The city is located into the North of Italy, inside the Emilia Romagna region. The metropolitan area comprises three different typologies of lands: a flat land marked by the presence of two important rivers (Reno and Panaro) and by the historical vocation to agriculture still on-going; a medium-land still flat, which is characterized by a more intense urbanization, with the increase of urban sprawl; the final area which is a mountain land (inside the Appennino Tosco Emiliano). The metropolitan area has an important vocation for naturalistic and environmental resources, which means that the area needs specific actions for the maintenance and the preservation of the landscape. There are, in fact, several instruments developed for this reason: the Territorial Plan for Provincial Coordination (Ptcp), the Provincial Energetic and Environmental Plan (Peap) and the Energetic Programme of the Municipaliy of Bologna (Pec). In addition, in 2013, a Climate Plan was approved for actions aimed at mitigating and adapting to climate change and for actions aimed at reducing GHG emissions. On the energetic point of view, the city has several planning instruments: the Climate Plan, the Action Plan for Sustainable Energy (Paes), the Integrated System for Energy Management (SIGE). As a general framework the city has several renewables sources for energy production: an increasing PV sector (see also the interesting experience of Solar Community described in next paragraph); the wind and hydroelectric power and increasing bio-energies. The attention to these green sources of energy is increasing year by year, not only on decision makers and PA level, but also on citizens level.
- **Mobility**. On the mobility level the city is a central territory for the North

3 The information provided into this paragraph are mainly coming for the Municipality Databases, available at: http://www.comune.bologna.it/iperbole/piancont/ and http://www.cittametropolitana.bo.it/statistica/Engine/RAServePG.php/P/265211010409/T/Ricerche-demoscopiche. In addition, some information are taken from (Papa et al., 2016).

Side of Italy because of the presence of an important railway exchanger pole. Into the city, in fact the train station is central and used by several users every day: the presence of Alta Velocità (the high speed line), of the regional line and of the airport make the city an exchanging pole not only for commuters but also for long-distance voyagers. Nearby this over-municipal system, the mobility system is also made by the public transport composed by bus, filo-bus and cycle lanes.

• **Citizens and cultural heritage**. The metropolitan area of Bologna, as well as the city, has an important presence of cultural heritage. All along the territory it is possible to find several sites going from the archaeological era to the modern age, which are important as heritage to be preserved. In particular, inside the city centre of Bologna there is a high concentration of this cultural heritage, with peaks of excellences under the UNESCO protection. It is important to notice that the same city centre of the city is under cultural protection because of the conformation of the built environment in itself[4].

Lot of data are available about citizens inside the metropolitan area (Città Metropolitana di Bologna, 2016). In general it is possible to highlight some aspects:

• presence of lots of commuters that every day moves for work or education reasons;

• elders (24,3% of people with more than 65 years old) surpass the percentage of young (13,1% of people with less than 15 years old);

• the average age is estimated around 40-55 years old;

• 15,5% of people have an university degree (23,5 % inside the city), 31,3% has a high school degree and 7,4% has no education degrees.

Finally, it is possible to resume the main strategy that the city aims to follow as a pathway for 2050, which is expressed by several plans and instruments. The most interesting are the following:

• **Covenant of Major subscription and the PAES (Piano d'Azione per l'Energia Sostenibile).** The subscription of the city into the Covenant of Major dates back 2008, when the project started. The main milestone for the participation into this covenant is the redaction of a SEAP (Sustainable Energy Action Plan) where targets as well as actions are described. The city of Bologna drawn the plan in 2011 and it was approved in 2012. Today, some monitoring and evaluation data are already available. After the analysis of main sectors' consumption, the city selected one major target to be achieved in 2020: the reduction of CO_2 emissions

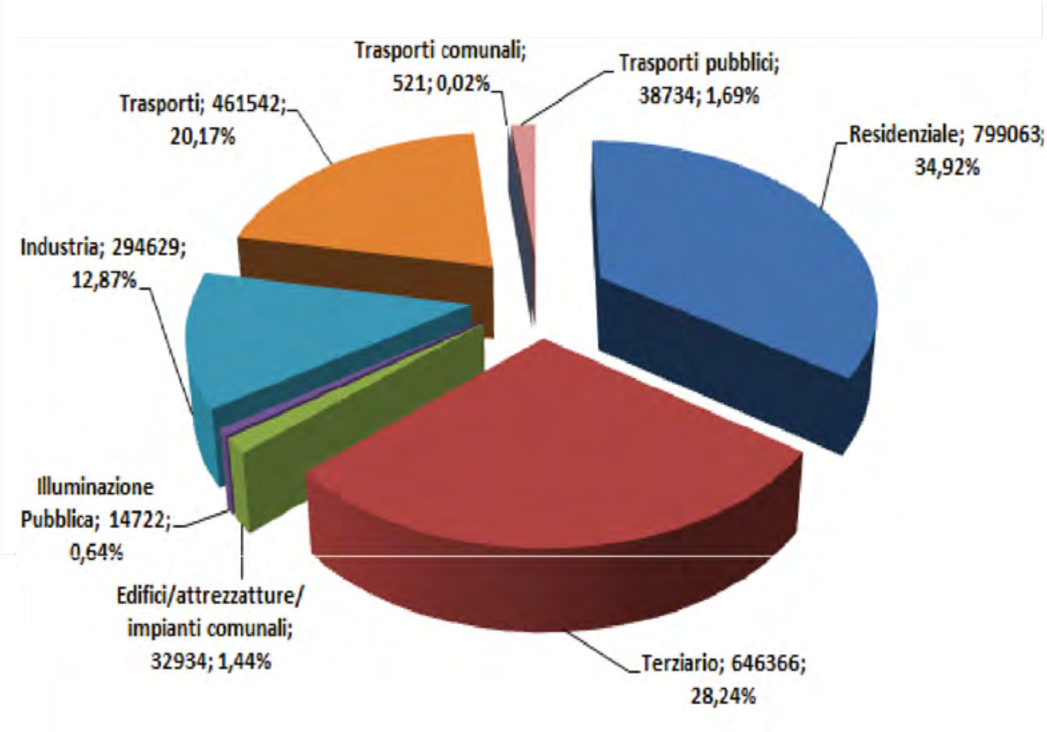
4 For more information see http://www.comune.bologna.it/politiche/cultura.

by 20%, which is equivalent to 456,709.8 tonnes of CO_2. Figure 5.2 visualizes the analysis based on 2005 of main sectors, highlighting how the most expensive sector, in term of CO_2 emissions, is the residential one with tertiary and transports. From this analysis, it is clear how the buildings sector (residential + tertiary) is responsible for the 60% of GHG emissions and constitutes the first and major target of intervention (Comune di Bologna, 2013). Even if the residential sector is recognised to be the most expensive for the city of Bologna, some big barriers are present. The main two obstacles for renovating the building sector are at first the presence of a fragmented property of buildings (65% of buildings or flats are owned by single persons). Secondly, each flat has an independent heating system. For this reason, the municipality decided to act as a first step into an ensemble of buildings owned by the public section, considering about 12,000 flats (see Rig. ener.a project, p. 253). This strategy was aimed at starting a deep renovation on a part of the built environment with the aim to increase the amount of buildings renovated after this pilot intervention. Another important obstacle to buildings renovation is that the most effective interventions (improving façades and roofs with insulation and substitution of windows) are the more expensive ones having a payback time estimated in 10-20 years, which makes investors less ready to finance them. The intervention of the public sector is for those reasons important and necessary in order to meet the target (Comune di Bologna, 2013). Aside from the general target to be achieved in 2020, the plan sets some yearly milestones per sector. These are resumed in table 5.1. The plan proposed an ensemble of 109 actions, where 39 were already been activated in 2012 (Comune di Bologna, 2013). The process with which the plan have been wrote and it is now under implementation is particularly interesting. In fact, the municipality organised several working tables with main stakeholders (from citizens to industry). In addition, the municipality defined a structure for the achievement of targets, by drawing a hierarchy of collaborations inside the public sector, with external partners and citizens. This process is important as it gives the dimension of the complexity behind the realisation of such project but also it gives the measure of the success of the plan. Figures (5.3; 5.4; 5.5) highlight the monitoring data made on 2015 on the basis of 2013 records. The first figure 5.3 defined the state of implementation of actions described in the PAES; while figure 5.4 and 5.5 visualize the variation of GHG emissions and energy consumption from 2005 (baseline year) to 2013. These figures put in evidence how the implemented actions[5] were been successful, as from 2005 it was recorded a reduction of emissions of almost 300,000 tonnes of CO_2, which describe an improvement of 12,4% (Urban Center

Table 5.1 Milestones and targets of the PAES. Source: (Comune di Bologna, 2013, p. 52)

Actions	Expected reductions (tonnes of CO_2/year)	Percentage of reduction in respect to the main target (%)
Actions on residential buildings	140.885	29,4%
Tertiary sector	120.801	25,2%
Local energy production	12.676	2,6%
Mobility and transport	96.610	20,1%
Energy consumption attributed to the municipality building	18.514	3,9%
Already started actions	90.043	18,8%
Total	479.530	100%

Figure 5.2 Analyses of CO2 consumption in main sectors. Source: (Comune di Bologna, 2013, p. 18)



5 Some of the main and more interesting actions and projects implemented with the SEAP are described in paragraph 5.1.2.

Figure 5.3 Status of implementation of PAES actions. Source: Covenant of Mayors

Figure 5.4 GHG emission per sector. Source: Covenant of Mayors

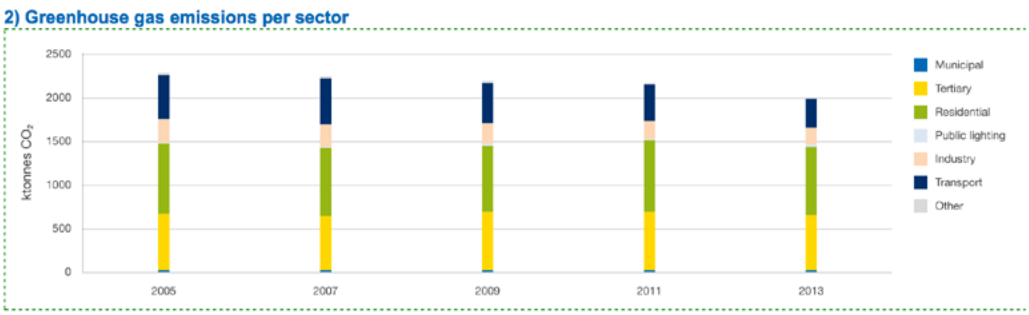
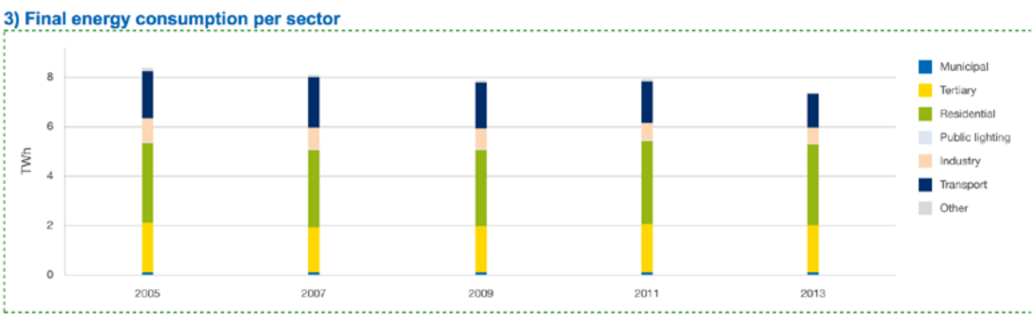


Figure 5.5 Final energy consumption per sector. Source: Covenant of Mayors



Bologna & Comune di Bologna, 2016). The main reduction was concentrated into the mobility sector and in particular into the private transport (-37,9%) one. This data can be explained with the improvement of the public transport and of cycle lanes. Conversely, the residential and tertiary buildings saw a very few reduction (only 2%). It is clear that this sector is the now main one for addressing energy consumption reduction (Urban Center Bologna & Comune di Bologna, 2016, p. 23).

- **BlueAp project and the Plan for adaptation to climate change**. The city recognises the need for implementing strategies to mitigate climate change. In particular the city is mainly affected by the following challenges due to climate change: droughts and water shortages; landslide/hydro-geological risk and extreme weather events; heat waves in urban areas (Comune di Bologna, 2013, pp. 93–94, 2015). Figure from 5.4 to 5.6 evidence the monitored data about climate conditions. The Local Climate Profile (Comune di Bologna, 2015) highlights the calculated scenario defining the following elements: 1) temperature is prospected to drop down seriously in the second half of the century, when the reduction will be -30% during the summer (in respect to the 1961-1990 period); 2) temperature has already increase by 3-4°C from 1990 and it is expected to increase more in the next 30 years. As well, the number of days with more than 33,7 °C is already increased. The strategy for adapting to such challenges comes from the BlueAp project, funded in the period 2012-2015 with LIFE+ programme. The results of this project are: 1) creation of the Local Climate Profile; 2) creation of a plan for adaptation; 3) implementation of a process for stakeholders' involvement as well as citizens' involvement; 4) implementation of actions. The actions implemented are both on municipal level and on the sovra-municipal one (Figure 5.6). The main implemented actions of this plan are the following:

  - Improvement of the Urban Building Regulation with new objectives for water savings;
  - Improvement of the Green Regulation, by preferring adaptive species to climate change
  - New permeable parking to avoid impervious surfaces (pilot action in via Larga-via dell'Industria)
  - Rain harvesting for agricultural use (pilot action in the University of Bologna – Cadriano laboratories)
  - drinking water replacement whit alternative water resources for parks (pilot action in Margherita Gardens)
  - renovation of drainage ducts (pilot action in Fiaccarolo drainage duct)

Figure 5.6 Bologna vulnerabilities. Source: PAES

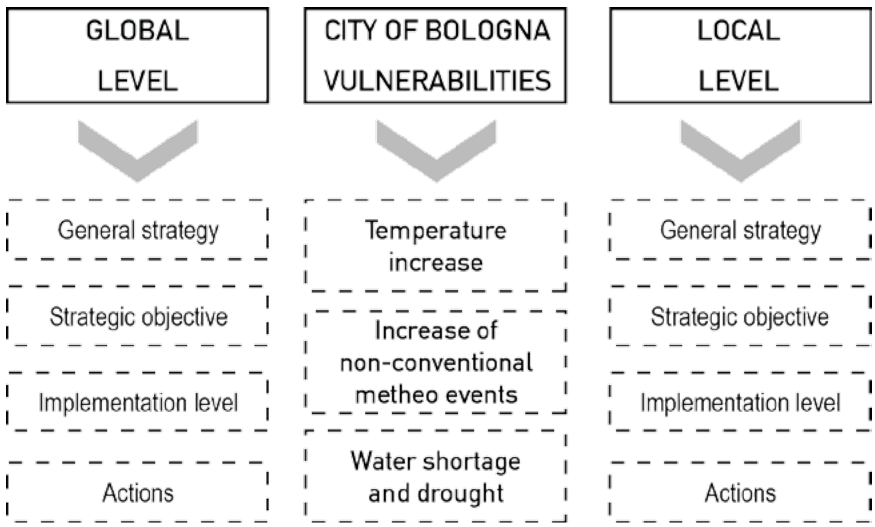


Table 5. 2 Observed challenges of the city. This is a personal analysis based on Bologna documents and reports

Challenge	Data
Drought and water shortage	1) the only supply source of water for aqueduct, old channels and water system is the river Reno, which has a very limited flow rate in summer;
	2) The progressive lowering of the ground level make the water collection from underground not allowed or limited.
	3) Water collected for private use (157 l/inh./day) = 43,2 millions of m^3 (M m^3)
	4) Water collected by agriculture = 2 M m^3 /year
	5) Water collected by industry = 2,7 M m^3 /year
Extreme weather events and hydro-geological risk	More than 50% of territory is impervious
	449 active landslides on the territory
Heat waves	Projections expect an average of +2°C during summer

Table 5. 3 Observed potentialities and weaknesses. This is a personal analysis based on Bologna documents and reports

Potentialities	Presence of an aware governance about climate change, innovation and citizens' wellbeing
	Presence of a multitude of already on-going projects
	Presence of a vibrant environment for innovation
	Already stimulated society into participatory approaches and involvement
Weaknesses	Presence of internal and external obstacles
	Need for more funds from the private sectors
	Disadvantageous payback time of the most important actions to be implemented

- involvement of Unipol association into the communication of climate change risks.

• **Strategic Metropolitan Plan (PSM)**. This is a programmatic and strategic plan for metropolitan governance. The first plan was drawn in 2013 (Comune di Bologna, 2014), the new one is under development in 2016. It develops the guidelines for the strategic development of the territory. The new plan already selected main guidelines for the future in continuity with previous guidelines. The new ones are the following (Comune di Bologna, 2016):

- To develop and improve the identity of Bologna as a good place for living, studying and working.
- To foster the renovation of the built environment, focusing on green energy, retrofitting, healthcare, green surfaces and mitigation to climate change.
- To improve the energy efficiency of the mobility sector and to reduce air pollution.
- New industries, knowledge and education as development engines.
- To put the cultural heritage in the centre of the metropolitan strategy.
- To improve the educative system from the beginning to university.
- To put healthcare and wellbeing at the centre of strategies.

• **Operative National Program for metropolitan cities (PON Metro) 2014-2020**. The program involves actions with a funding of 40 millions of euro. The process involved in a participatory approach citizens, associations and public administration. Actions are expected to start in 2017 and end in 2023. They are divided into six axes:

- Metropolitan digital agenda (5.357.425 €);
- Public services and urban mobility sustainability (11.500.000 €);
- Services for social inclusion (9.830.384 €);
- Infrastructures for social inclusion (10.032.191 €);
- Technical assistance (1.050.000 €).

• **Plan for urban innovation** (2016). This action plan is complementary to the PON Metro operative program, as it is the consequence of the participatory approach developed under the project "Collaborare è Bologna", where all the six urban districts and more than 1200 citizens participated for the definition of 500 actions. The Plan for Urban Innovation has been presented the 15 December 2016 and it is based on urban regeneration actions. Inside the plan some priority action area have been identified. Some of them are inside the Bolognina area (e.g. Mercato Navile, Train Station) and the Bolognina neighbourhood in itself is mentiones as prioritary intervention area in its complexity.

These plans define an interesting environment for applying piloting and innovation actions. However, some potentialities and weaknesses can still be highlighted.

5.1.2 Projects for Bologna as a pathway for 2050

In this paragraph are briefly described some of the more interesting projects on-going in Bologna. They are mainly part of actions contained in plans described before.

- **PEEP Corticella**. This project involves the social housing district in Corticella (a municipality near Bologna, inside the metropolitan area). Inside this district, in 2012, through an agreement among municipality, University of Bologna and a consortium made by public and private partners, a district heating system was installed for serving 938 housing and some district services (a day hospital, a market, etc.). The extension of the district heating is 4 km with a surface of 22 ha. The system is correlated by sensors and instruments for thermoregulation and accounting of each single unit. The estimated saving is 23% of energy, 36,5% of CO_2 emission saved.
- **Solar Local Community**. Solar Local Communities are associations of citizens paying a quote for reducing their energy bill by renting PV panels. PV panels are normally located on the roofs of public buildings and are bought by the municipality. Part of these panels is then assigned to the community. In this way citizens can afford to have a quote on PV panels and gain a discount on the bill proportional to their quote.
- **GAIA project**. This is a PPP (public – private partnership) project for urban forestry inside the city of Bologna, coming from LIFE+ 2010 Framework Program. With an active stakeholder involvement, the project develops a protocol agreement, three technical annexes and a model for calculating the CO_2 produced by industries and SMEs. The aim of the project was to create a form of governance able to give to industries and SMEs an instrument for really mitigate CO_2 emissions from their daily work. The model gives a calculation of the achieved mitigation with the use of different tree species. Today the projects allowed the plantation of 1,321 new trees, which produced an estimated saving of 3,963 tonnes of CO_2.[6]

6 For more information see also: http://lifegaia.eu/

- **Green ASP project**. This project regards buildings of properties of the ASP (Azienda Pubblica di Servizi alla Persona = Public Agency for People Services) deriving from bequests and inheritances. The state of this patrimoine create the necessity for the Agency to intervene in order to improve the energy efficiency. The project started in 2015 aiming to improve the economic sustainability, the energetic sustainability but also people comfort, wellbeing and safety. The Agency started with the identification of an energy manager and a general strategy for intervention. This was conceived in order to be repliable and scalable.
- **CAAB district retrofitting**. The CAAB (Bologna Agri-Food Centre) is a district in Bologna where several industries, linked with agriculture and food, are settled in. Some interesting actions are on-going into this district for improving energy efficiency and, in particular, for improving the local production of RES. The CAAB has now the biggest PV system in Europe with 100,000 m^2 of surface involved and 43,750 PV panels. The funds of 22,5 millions of euros create a production of 11,350,000 kWh per year. The industries inside the centre are self-sufficient and the surplus of energy will be soon made available for the nearer territory. The estimated savings, coming for this system, are the equivalent of 5,250 tonnes of CO_2/year.
- A second interesting project on-going into the CASSB is the so called **Moving Sun project**. This is a project for reduction the air pollution due to diesel means of transport in the field of goods distribution. In particular, the project provides electric vehicles to CAAB industries in order to avoid the distribution of food and agricultural goods into the city centre with fuelled-vehicles. It was in fact estimated that in the city of bologna 25% of transport is due to goods distribution, that 60% of emissions of NOx are due to the same reason. In addition, the 67% of vehicles is now riding with menus that 25% load. The presence of a EV fleet is added to an ICT platform. The estimated savings, coming for this project, are the equivalent of 10 tonnes of CO_2/year.
- **Tangenziale Bicicletta project**. This project implemented in 2015 a continued highway for bikes all around the city centre of Bologna, on the main external ring. The aim of this project is to promote the use of bikes by citizens.
- **Rig.ener.a project**. The project addresses the renovation of a part of the residential built environment into the municipality of Bologna. The main characteristic of this heritage is the public properties and the presence of a unique association (Acer) charged of the maintenance. The project defined the guidelines for an energetic retrofitting, by using a coordinated partnership among

the municipality, ACER and the university. The intervention is made by using an EPC and the presence of an Esco in order act without asking funds to users (Urban Center Bologna & Comune di Bologna, 2016, p. 29)[7].

- **Contratti di quartiere II (District Contract II)**. These are two plans for urban renovation targeted at improving the urban quality of two areas in Bologna: inside the district Bolognina (2 buildings) and San Donato. In both case the strategy, due to the decay of buildings, was to re-built them with eco-friendly and innovative materials. A connected social engagement was organised. Also this intervention is made in collaboration among CAN, Unindustria, BPER, Unipol Bank and the municipality (Urban Center Bologna & Comune di Bologna, 2016, p. 32).

5.1.3 Overview of the district: Bolognina as extension of the city centre

The neighbourhood of Bolognina is a big area in the city of Bologna inside the Navile district[8].

Into the XIX century the district become an important industrial site because of the presence of the train station. Before being an industrial site, it was devoted

Figure 5.7 Aerial view of the Navile district. Bolognina neighbourhood is evidenced with white line

7 For more information see also: http://www.comune.bologna.it/news/rigenerazione-energetica-23-edifici-acer

8 Please note that the research decided to use district for the Navile area and neighbourhood for the Bolognina one. In history, Bolognina was a separated district from the Navile, but in recent years the PA decided to create a larger district, including inside Bolognina. As a consequence, for administration identification the research decided to tell about Bolognina as a neighbourhood as, in addition to administrative identity it has an important historical and social identity.

to agriculture. During the Second World War the district was an important military target because of different arms industries. It is after the war that a consistent part of the neighbourhood becomes the home for industry's workers, with the built of the first social houses. It is only during the 80's that the social cohesion of the area starts to disintegrate: the end of some of the industries, the pressure of speculation as well as the migratory flux start to undermine the social unity of the district. Today the district is composed by different typologies of residential housing, both social and normal and this extension goes from the train station to the hippodrome, in the north part of the city. Into this big district there are some specific areas that become of big importance due to the starting of different actions of retrofitting. In particular, the boundaries are currently subject of a great transformation:

- the new project for the train station, aiming to reconnect the different parts of the city and to create a new shopping and social area;
- the development of the new City Hall building, bringing into the community new people and new flux of money and sociality;
- the new urban development nearby the City Hall that bring new typologies of residential houses and new urban quality into the district;
- the general attention of the municipality to the themes of resilience and energy efficiency of the city, that give new perspective of development and retrofitting in some of city's boundaries. It is into this vibrant and changing environment that the Bolognina district is located.

Bolognina is the heart of the railway city area and a home area for 35 000 inhabitants. Due to physical degradation of the buildings and complex social structure, the district is particularly exposed to the impacts of climate change. Most important aspects to consider in this field were: heat waves, drought and water scarcity, extreme rainfall events and hydrological risk (Profilo climatico locale).

5.2 Green City Circle simulation

This paragraph is intended to give an example of the GCC application into a real context. The Bolognina district is a big district whit several challenges. The research was focused not in the whole district but in a specific portion, considered as of great interest because of the challenges that takes with him. This is the south part of the district characterized by the following boundaries:

Figure 5.8 Portion of Bolognina neighbourhood considered for KPI calculation

Figure 5.9 Main non-physical / physical barriers inside the portion of neighbourhood considered

- a new urban development linked with the City Hall,
- the new City Hall,
- the central train station,
- the via Matteotti street, which is the direct continuation of the via Indipendeza (the main commercial street of the city centre).

Into this boundary the research gained specific data on public owned residential buildings, managed by the ACER association. These buildings are mainly organized around courtyards, as common into the city of Bologna both on the historical part and on the more recent one. Into this boundary the community is multi-ethnic and the income is low and uniform. All data come from an intensive relation and discussion with the municipality of Bologna.

Although the difficulties in the community dimension, there are several vital parts inside the area: one of them is the daily market, located on via Albani, in a centric position in respect with the neighbourhood. Also if the district is located geographically into a central part of the city, there is an immaterial and material division with the rest of the city due mainly to the presence of the train station and the railway.

With the new project of the station this physical barrier will be removed and the district will become aa extension of the city centre.

The following paragraphs focuse on the application of the GCC into this context by describing each steps of the model.

5.2.1 Step 1 and 2: situation analysis and target selection

The situation analysis of the selected neighbourhood can be defined through the compilation of the preliminary checklist, through observations and spatial analysis on the basis of maps.

Preliminary checklist

The preliminary checklist (Fig. 5.10) highlights some interesting data.

First of all the district is highly dense, with 34,908 inhabitants and a density of 7,102.6 inhabitants per km^2. This density is comparable to Milan (7,403.02) and Lisbon (6,442.72) density, while the average Bologna density is lower (2,750.72). The land density was calculated as 4,43 m^3/m^2.

The district is mixed-used with the important presence of businesses, schools, services, the new City Hall, a daily food market and residential buildings. On the social point of view, the district records the presence of several immigrants

Figure 5.10 Preliminary checklist for the Green City Circle Assessment

n°	Question	Answer
Theme 1: General information about the district		
1.1	How many inhabitants has the district?	The Bolognina district has 34,908 inhabitants
1.2	What is the density of the district?	7,102.6 inhab/km^2
1.3	What kind of district is it, on the functional point of view (mixed-used, residential, commercial, etc.)?	☒ Mixed-used ☐ Residential ☐ Offices ☐ Commercial ☐ Touristic ☐ Productive ☐ Brownfield ☐ Other:
1.4	What specificities the district has on the social point of view?	- lot of immigrants and multi-culture residents (13 different ethnicities) - presence of two main different communities: the one going to the city hall and the district's residents
1.5	What specificities the district has on the urban point of view (conformation, position, etc.)?	The district is located near the Rail Station, near the city centre (1,5 km), near an evolving educational district.
Theme 2: Sustainability of the district		
2.1	Are there some NZEB buildings? If yes, how many?	☐ Yes ☒ No If yes, please describe it:
2.2	Is it a low-carbon district?	☐ Yes ☒ No If yes, please describe it:
2.3	Are there applied some measures for mitigation and adaptation to climate change?	☐ Yes ☒ No If yes, please describe it:
2.4	What measures of sustainability the building's sector has?	☐ Active energy efficiency measures (performing systems) ☐ Façade and roofs insulations ☒ PV panels of green energy systems ☐ Performing windows ☐ Other: some buildings (Rigenera projects) have implemented some lighting system and windows replacement
2.5	What measures of sustainability the mobility sector has?	☒ EV ☐ E-bikes

		☐ Presence of multimodal mobility network ☒ Presence of park-n-ride systems ☐ Presence of low mobility network ☐ Presence of sharing mobility ☒ Presence of efficient or sustainable public transport ☐ Other
Theme 3: Smartness of the district		
3.1	Does the district have some smart devices (any kind of)?	☐ Yes ☒ No If yes, please describe it:
3.2	Does the district have some strategies for social smartness?	☒ Living Lab ☐ Educational program ☐ Sharing communities ☐ Other (please specify): there are some interesting associations
3.3	Does the district have some strategies for grid management?	☐ Yes ☒ No If yes, please describe it:
3.4	Does the district have some monitoring systems?	☐ Air pollution system ☐ Building management ☐ Energy consumption at the district level ☒ Other (please specify): no the district has no monitoring systems
3.5	Is the city implementing a holistic strategy for smartness?	☐ Yes ☒ No If yes, please describe it:
Theme 4: Resilience of the district		
4.1	Does the district have problems caused by climate change?	☐ Flooding ☒ Heat island ☒ Heat waves ☒ Drought ☐ Other:
4.2	Is the district, or the city, implementing measures for adaptating to climate change?	☐ Yes ☒ No

			If yes, please describe it:	
Additional challenges				
A1	From the list below, what are the 5 main challenges that you need to face in your district?			
	☒	Fuel poverty	☐	Heat waves
	☒	Microcriminality or delinquency	☒	Heat island
	☐	Organised criminality	☐	Food shortage
	☐	Healthcare problems	☐	Water shortage
	☐	General social challenges	☐	Dis-comfort outdoor
	☐	Absence of services	☒	Absence of spaces for sociality and of play grounds for children
	☐	Absence of eldercare	☒	Dis-comfort indoor buildings
	☐	Absence of educational services	☐	High building energy consumption
	☐	Flooding	☐	Absence of low mobility and green mobility
	☐	Drought	☐	Absence of efficient and sustainable public mobility
	☐	Brownfield presence	☐	High losses (thermal, water) at the district and grid level
	☐	Absence of funding	☐	Challenges on particular spaces related with specific hours
	☐	Absence of people participation on social life and civic engagement	☐	Ecosystem challenges
A2	From the previous list, can you order the 5 main challenges you choose per importance?			
	1	Fuel poverty		
	2	Heat island		
	3	Absence of spaces for sociality and of play grounds for children		
	4	Microcriminality or delinquency		
	5	Dis-comfort indoor buildings		
A3	Per each challenge, what action (urban, political, social,etc.) do you thing can trigger the change?			
	1	Decrease building's energy consumption (to obtain lower bills) + investment on social RES (e.g. Comunità Solari)		
	2	Improvement of open space between buildings (vegetation, transpiration, ceiling)		
	3	Improvement of the available space quality		
	4	Improvement of public space quality with the consideration of challenging hours (designing with time)		
	5	Actions on the façades (insulation+thermal mass) and on energy management		

and multi-culture residents (with the definition of more than 13 different ethnics) (see Interview 1 on Annex II.3).

In addition, it is possible to highlight that several groups of users of the district are present: two of them are people living inside the neighbourhood and using residential buildings and services as resident and people working inside the district (mainly inside the municipality but also inside other businesses). Figures 5.12-5.13 visualizes these main users groups adding information about the time of district use and main flows.

On the urban point of view the district is located near the city centre of Bologna (1,5 km from the center) near an evolving educational and governance pole.

Theme 2 of the checklist is aimed to highlight the sustainability of the district. In this case, it is possible to highlight how the district has no specific measures for sustainability except of the presence of an EV fleet (used by the municipality), of some PV panels on roofs and of some renewal made under the Rigenera project (see paragraph 5.1.2). It is also possible to highlight that the district has an efficient public transport system with the presence of trains and buses.

Theme 3 of the checklist is aimed to highlight the smartness of the district. Into this case, it is possible to affirm that the district has no smart projects or devices already implemented (Interview 1 on Annex II.3) .

Theme 4 highlights the resilience of the district. The Bolognina context analysed has no specific measures already implemented to mitigate climate change. Nevertheless there is a big potential in the presence of green spaces

Figure 5.11 Main distances between city center and Bolognina sections

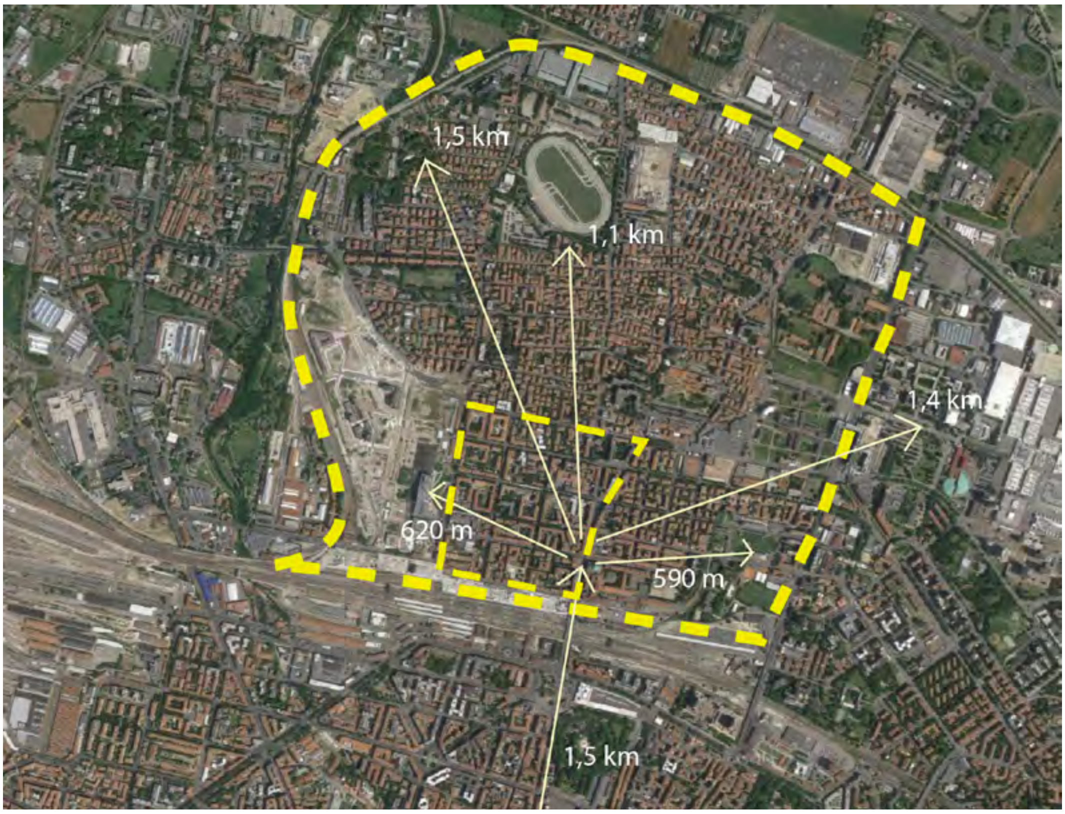


Figure 5.12 Analysis of users. Schemes

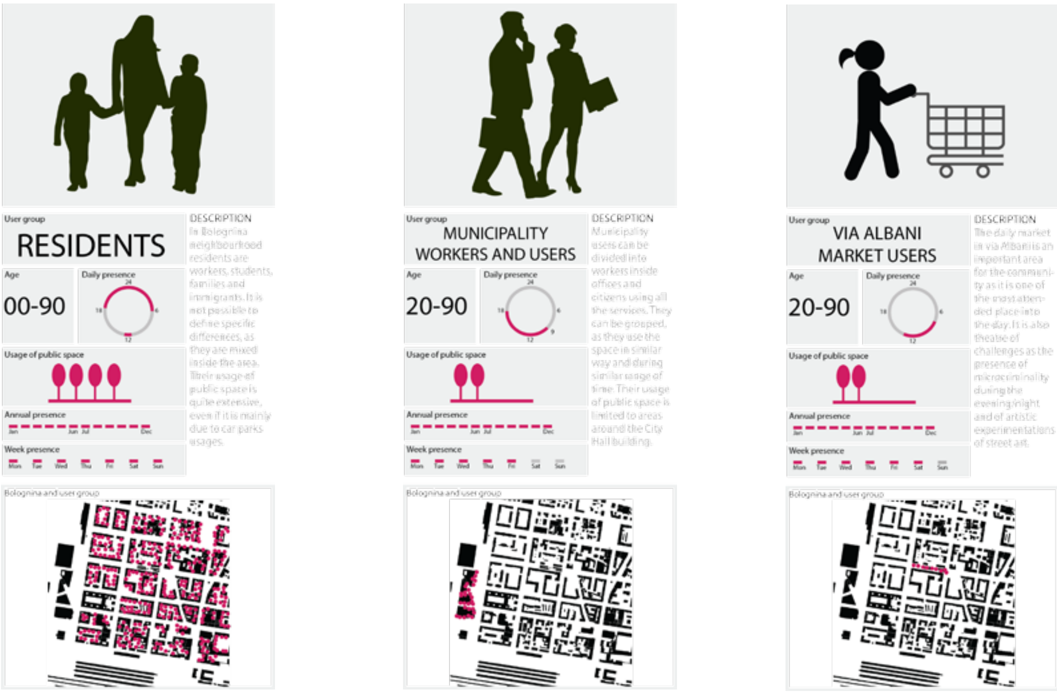
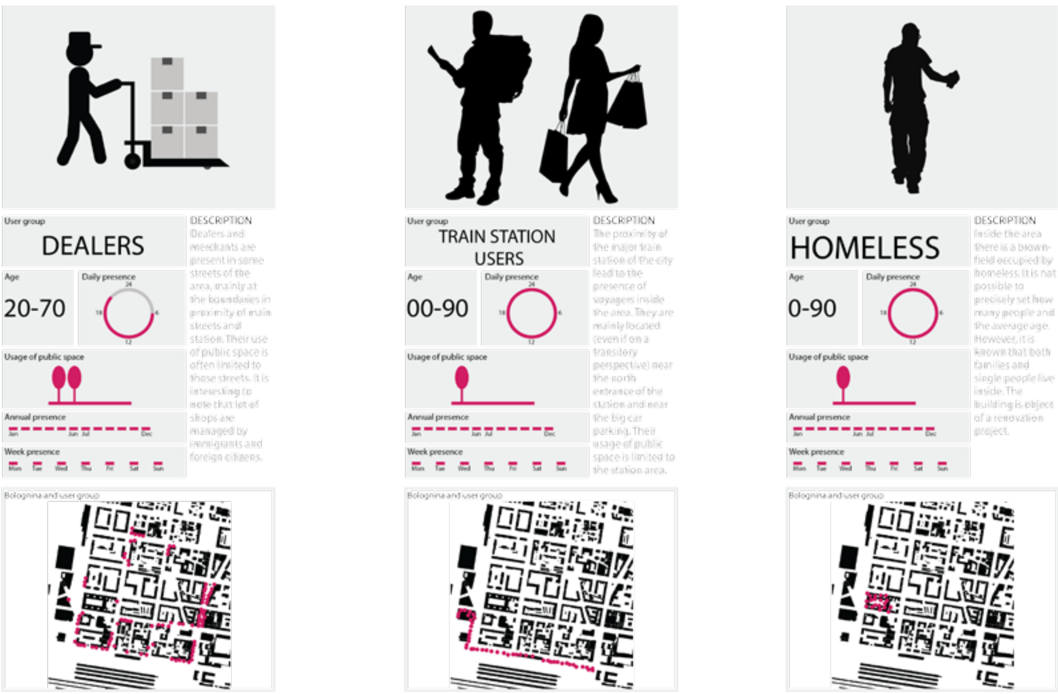


Figure 5.13 Analysis of users. Schemes



(courtyards, schools gardens and sport fields). The main challenges linked with resilience are heat islands and heat waves, as well as water scarcity and droughts.

The main additional challenges that the district presents are the following:

- Fuel poverty. In recent years, in part due to the economic crisis and to the increased rate of unemployment, inside the context lot of experiences of fuel poverty were recorded. Some families admit to don't being able to afford energetic bills for heating during winter (data from participative observation and citizens interviews, see Annex II.1, p. 334.
- Micro-criminality and delinquency are also attested phenomenon inside the area. In most cases, they are linked with drug traffic (Interview 1 on Annex II.3).
- Absence of safe spaces for children and families as playground and open sport facilities.
- Dis-comfort inside buildings due to their energy performance.

The preliminary analysis is conducted mainly through the analysis of documents and reports on the district, but also with a participative observation, which was conducted on the district personally during 3 months, from April to June 2016.

1st set of indicators and deepening

For a speditive analysis the application uses the 1st set of indicators provided by the GCC. Following are highlighted the calculation for each of the 11 indicator composing the 1st set.

Indicator 1: energy consumption of buildings. The calculation is made on the basis of data provided by ACER and the municipality. The average kWh/m^2y calculated using the UNI TS 11300 legislation for heating is in general more than 210 kWh/m^2y.

Indicator 1: calculation	Points assigned
210 kWh/m^2y	1

Indicator 2: Percentage of RES. No aggregated data are for now available on the percentage of renewables used inside the district. Some data are available on the presence of some PV panels on roofs, but these are only two episodes, without any effect on the general average of the district. This indicator can be evaluated as less than 19% of total energy, provided by RES.

Indicator 2: calculation	Points assigned
< 19%	1

Indicator 3: Buildings density and canyon geometry. The density was calculated on the basis of a spatial analysis, based on maps, as no data were already available. The density of the portion of district considered is 97,994 m^2 on a surface of 0,29 km^2. The people density was calculated as 7,102.6 inh./km^2. The land density was calculated as 4,43 m^3/m^2.

The street canyon is evaluated on the basis of a deep analysis of each typology of street sections present into the district. These typologies are 4 (5 with via Matteotti, which is the direct prosecution of the main city centre street; 6 with via Carracci, which is the street facing the railway station) and differ for the typology of lanes, the presence of trees and the dimension. The average ratio of street canyon is 1, which means that they are regular canyons, with an high length (average more than 500 m long). Some exception are given by the via Artistotile Fioravanti, which can be considered an Avenue canyon, because of the presence of a green square; via Rosaspina and via Costa, which can be considered deep canyons. A photographic overview of each street canyon is provided in Annex II.2 (p. 338).

On the qualitative point of view, the personal observation on the district recorded the presence of trees and vegetation in almost all streets, the presence of cycle path separated from the vehicle one only in one major street (the one facing the new City Hall); the presence of garbages and simple access to buildings in some streets and lighting in the majority of streets.

Indicator 3	**Calculation**	**Points assigned**
Density	4,43 m^3/m^2	/
Sky View Factor	ND	-
Canyon geometry	1	2
Qualitative analysis	0,25 (trees)	1
	0,25 (cycle path)	
	0,25 (access)	
	0,25 (street lighting)	
Total		3

Indicator 4: anthropogenic heat. As already explained in chapter 3, into this research the anthropogenic heat is calculated only for the buildings' part, in order to have an estimation rather than a precise evaluation. For this application the calculation is based on an average based on available data. In particular, the calculation is made on buildings where were available both thermal conductance and architectonical designs. It is here believe sufficient as the application is an

example and as the buildings present in that area were made almost in the same historical period.

$$Q_f=UA\Delta T_{(i-e)}$$

Applying the equation to the buildings, it becomes:

$$Q_{fwinter}=1.88\ W/(m^2\ K)\times 1000\ m^2\ (293.15-278.15)K=28{,}200\ W$$

In winter, when the temperature is lower outside than inside the calculation shows how the warm goes from inside to outside (sign + of the equation), adding to the street anthropogenic heat a quote of 28 kW, coming from buildings envelopes.

$$Q_{fsummer}=1.88\ W/(m^2\ K)\times 1000\ m^2\ (293.15-297.15)K=-7{,}520\ W$$

In summer, when the temperature is lower inside than outside the calculation shows how the warm goes in the other direction (sign - of the equation), adding warm inside for a quote of 7,5 kW. Of course, this data is because the internal temperature is fixed at 20°C. This happens if inside there is a cooling system. In this case, it is necessary to add to the street heat the heat coming from the cooling system. For the application of the model, here, it is considered the data coming from the winter analysis.

Indicator 4: calculation	**Points assigned**
< 9 W/m^2	1

Indicator 5: evapotranspiration ratio. The calculation is made on the basis of a spatial analysis made on the same area that the previous one.

The calculation is made on the basis of the following expression:

$$ER=(A_i\times 100)/A_{tot}$$

The result on the selected area is 89% of average impervious surface.

Indicator 5: calculation	**Points assigned**
89%	1

Indicator 6: PMV – Thermal comfort. The PMV index calculated by using the

Indicator 6	**PMV**	**Air T**	**Thermal sensation**	**Points**
8:00	-0.21 / 0.91	22-24 °C	From slightly cold to slightly warm	5
10:00	1.23 / 1.98	26-28°C	From slightly warm to warm	4
13:00	2.12 / 3.71	31-33 °C	From warm to hot	2
16:00	2.51 / 3.91	33-35 °C	From warm to hot	2
19:00	2.70 / 4.46	33-35 °C	From warm to hot	1
Average				2.8

Figure 5.14 Envimet example simulation (8:00 - 23/06/2015)

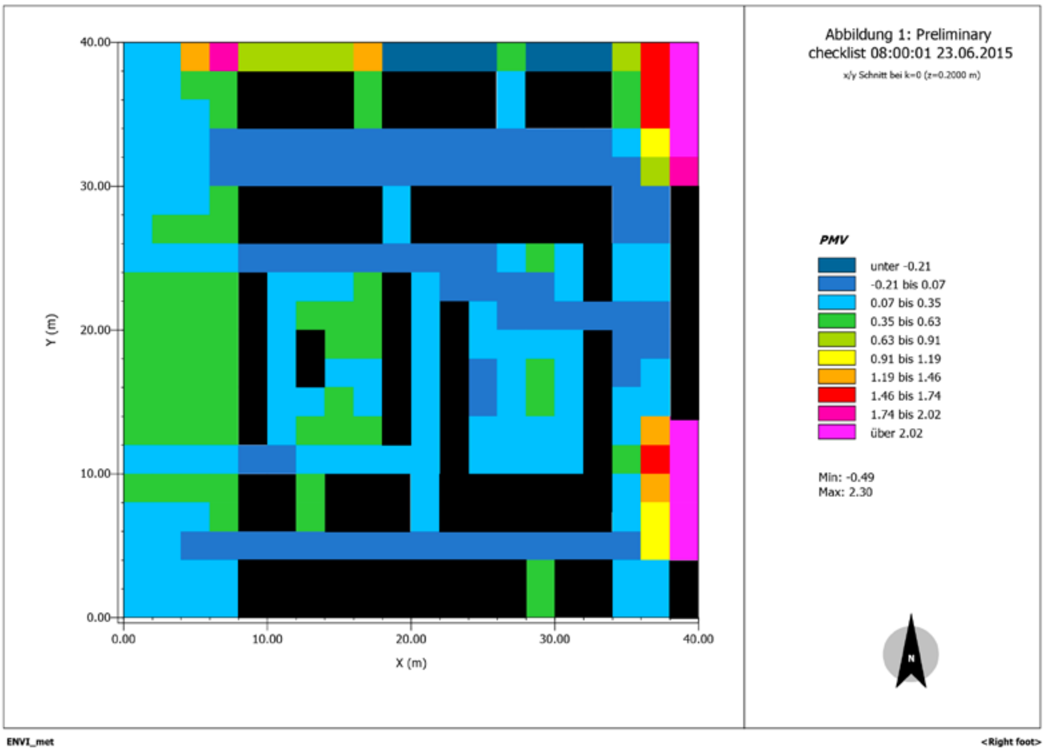
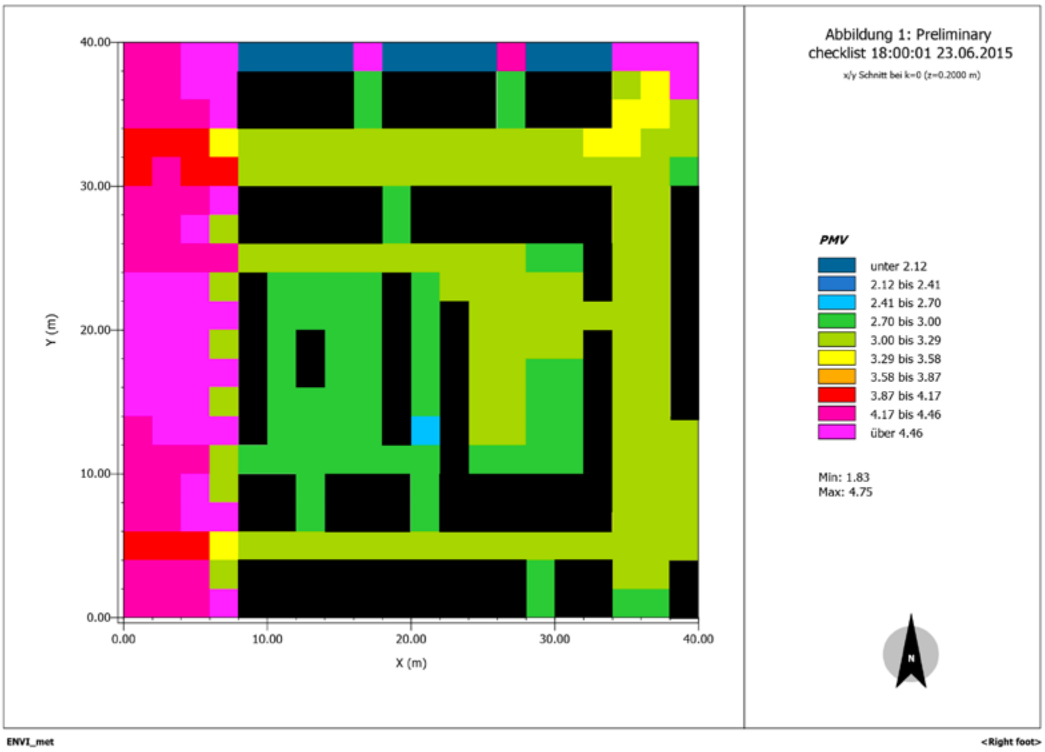


Figure 5.15 Envimet example simulation (18:00 - 23/06/2015)



Envimet software shows different results for different hours. The final calculation is given by doing the average of the single hour steps. The simulation is conducted on the 23 June 2015, putting real data of temperature and humidity, using one of the courtyard as a sample (see Figure 5.14 and 5.15).

Indicator 7: distribution of vegetation. As the photographic analysis on Annex II.2 shows, the presence of trees into the district is big and well managed, even if the impervious rate remain high, the presence of trees is important for mitigating air pollution and climate change in general. What it is important to highlight is that some trees are directly included into the asphalt of the street, which is not the best solution in term of vegetation wellbeing and maintenance. It is possible to say that more than 50% of streets have linear trees distribution and that more than 50% of open spaces (courtyards) have wooden distribution.

Indicator 7: calculation	**Points assigned**
More than 50% of streets have linear trees distribution	2
More than 50% of open spaces have wooden trees distribution	3
Total	5

Indicator 8: air pollution. No specific data are available for air pollution inside the selected district. The research recommends, as a major action, to install sensors for monitoring.

Indicator 8: calculation	**Points assigned**
ND	0

Indicator 9: green public transport penetration. Also this indicator is calculated on the basis of a spatial analysis.

Indicator 9	**Calculation**	**Points**
Radius distance among buildings and multimodal parking <500 m	< 500 m	1
Radius distance among buildings and normal bus stops <200 m	< 200 m	1
Presence of parks for bike sharing or car sharing	2	1
Total	3	

Indicator 10: presence of ICT devices. No ICT devices are present into the area.

Indicator 10: calculation	**Points assigned**
No data	0

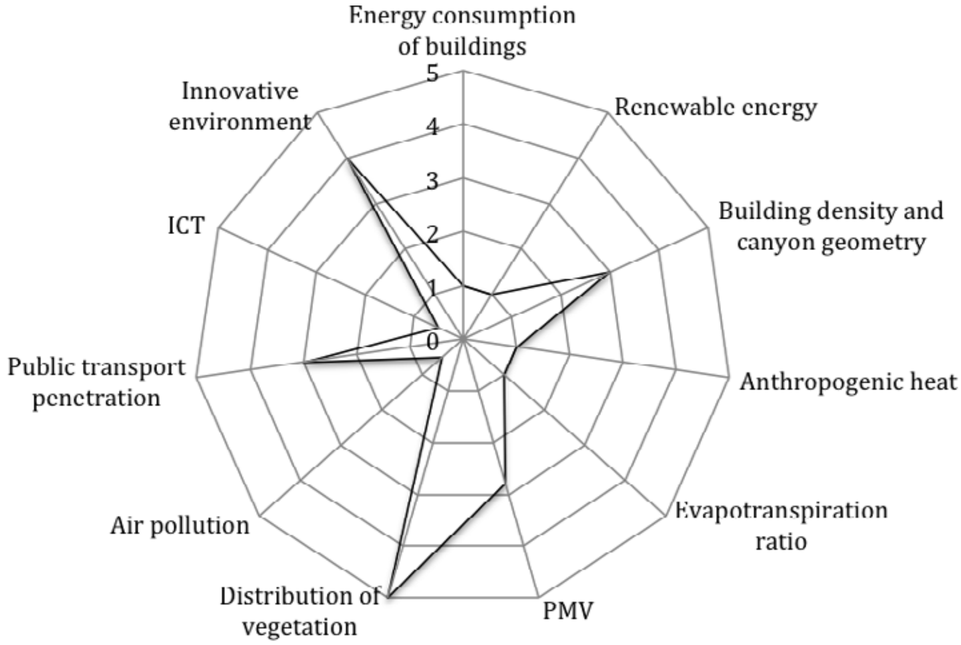
Indicator 11: calculation	Points assigned
Presence of living lab	1
Presence of artists	1
Presence of associations active on the community and the urban environment	1
Presence of participative approach	1
Total	4

Indicator 11: innovative environment. Inside the selected district it is possible to highlight how the environment is vibrant and innovative. This is mainly due to the presence of some artists living labs and of some associations active into the territory. These are the following:

1) the association of artists Checkpoint Charly [9]. They create an artistic living lab;

2) Bolognina Basement, an indipented cultural association based on Bolognina[10];

Figure 5.16 Preliminary analysis spider graph



3) BAUM Bolognina Arti Urbane in Movimento, which is a Cultural Festival of

9 See also: http://www.bologninabasement.it/checkpoint-charly-gli-artisti-della-porta-accanto/ and https://www.facebook.com/Checkpoint-Charly-329122980528992/timeline/

10 See also: http://www.bologninabasement.it/chi-siamo/

Art based on the district.

4) The participatory approach Convivere Bolognina.

As a result of this evaluation, the spider graph on Figure 5.16 can be visualized.

For the target selection it is possible to use a simple schematic worksheet (see Figure 5.17). The important element is to think about the timing approach of the strategy. The targets were selected on the basis of 3 main sectors.

5.2.2 Step 3: scenario definition

The scenario analysis is based on the same indicators used for the preliminary analysis. The data, needed for assessing scenarios, are specific of each territory and challenges. Three main scenarios are defined: the first one is the business as usual scenario, where the possible future without any kind of mitigation and adaptation actions is highlighted. Then, the scenario 2 and 3 are two alternative scenarios. For each of them, the research decided to focus on one main goal at first. In fact, those scenarios can be evaluated as first step hypothesis.

Scenario 0: business as usual

The scenario zero, called "business as usual", is aimed at foster a reflection on what would happen into the district, if no actions would be implemented. For each indicator a reflexion is made. Some prospective data and climate scenarios are already available from studies on the city of Bologna. In particular, the Climate Local Profile (Comune di Bologna, 2015) showed the following elements:

- Potential drop on the average annual rainfall, with an expected reduction (after 2050) of 30% in summer.
- Increase of temperature both as annual and seasonal augmentation. An increase of 2-4°C is expected.

The main results of these projections are defined as following:

- Heat waves
- Droughts and flooding
- Landslides and hydrogeological problems
- Water shortage.

The analysis is so conducted on the basis of these information and it is resumed in table 5.4.

Scenario 1

Table 5. 4 Scenario 0 “business as usual” KPI evaluation

Indicator	Reflexions	Output
1. Energy consumption of buildings	If no renovation measures will be done, it is conceivable to say that buildings could consume more energy because of the increase of temperature (e.g. this will lead to the necessity of improving more and more cooling systems). Also problems related to maintenance of building could occur. In addition, the scarcity of resources could exacerbate the phenomenon of fuel poverty and indoor dis-comfort.	1
2. Percentage of RES	The percentage of energy produced by renewable energy is directly linked with the decision to implement systems or not. It is reasonable to say that without interventions the score will stay stable.	1
3. Building density and canyon geometry	It is reasonable to say that without interventions the score could stay stable.	3
5. Anthropogenic heat	The heat on open space is due to thermal transmittance of surfaces, but also to mobility heat, systems heat, etc. With the increase of temperature and the technological innovations, it is reasonable to consider that this indicator could worsen, quite rapidly (e.g. if each flat implements cooling systems the heat due to these would augment exponentially).	1
5. Evapotranspiration ratio	It is reasonable to say that without interventions the score could stay stable. Even if the indicator in itself could not change without physical changes. The absence of actions can lead to major problems such as the worsening of flooding or heat waves, etc.	1
6. PMV – Thermal comfort	It is reasonable to say that without interventions the score could worsen due to climate change and in particular to the raise of temperature. Doing a try whit the Envimet software and putting +2°C on the settings, it is possible to see and someway calculate the worsening.	1
7. Distribution of vegetation	It is reasonable to say that without interventions the score could stay stable. Even if the augmentation of temperature and the inconstancy of rainfall could lead to maintenance problems of the vegetation. With this reflection it is possible to attribute a slight worsening of the indicator.	4
8. Air pollution	Even if no data are available for the specific district of Bolognina (as there are no sensors for monitoring actually existing in the area), it is reasonable to say that without interventions the score could worsen. In particular, without any intervention of traffic and car penetration and use into the district, as well as without the reduction of high consuming cooling and heating systems.	0
9. Green public transport penetration	It is reasonable to say that without interventions the score could stay stable.	3
10. ICT devices	It is reasonable to say that without interventions the score could stay stable.	0
11. Innovation environment	It is reasonable to say that without interventions the score could worsen. In particular, it is possible that without any involvement and recognition of the existing living lab the actual innovative environment could decline, in favour of more active and comfortable spaces in the city.	2

Figure 5.17 Target checklist for the Green City Circle Assessment

n°	Target	Selection
0.0	Which time targets do you want to select? Please note that several targets can be selected.	☐
		☐
		☐ 2020
		☐ 2050
	Target 1: Sustainability of the district	
1.1	Percentage of energy savings before 2050	☐ 20%
		☐ 30%
		☒ 50%
		☐ 100%
		Other:
1.2	Percentage of energy savings before 2020	☒ 20%
		☐ 30%
		☐ 50%
		☐ 100%
		Other:
1.3	Percentage of energy coming from renewables sources	☒ 20%
		☐ 30%
		☐ 50%
		☐ 100%
		Other:
1.4	Buildings renovations	☒ Yes
		☐ No
1.5	Mobility renovations / improvements	☐ Yes
		☒ No
1.6	Air pollution	☒ International targets
		☐ More than international targets
	Target 2: Smartness of the district for 2050	
2.1	Implementation of smart devices (any kind of)?	☒ Yes
		☐ No
2.2	Implementation of strategies for social smartness?	☒ Yes
		☐ No
2.3	Implementation of strategies for grid management / district heating, etc?	☐ Yes
		☒ No
2.4	Implementation of monitoring system?	☒ Yes
		☐ No
2.5	Implementation of a holistic strategy for smartness	☒ Yes
		☐ No
	Target 3: Resilience of the district	
3.1	Implementation of permeable surfaces	☒ Yes
		☐ No
		If yes, please indicate a percentage:
3.2	Implementation of green surfaces / trees	☒ Yes
		☐ No
	Additional targets	
	Additional challenges to be addressed:	2020 2050

	☐	Fuel poverty		☒	☐
	☐	Microcriminality or delinquency		☐	☒
	☐	Organised criminality		☐	☐
	☐	Healthcare problems		☐	☐
	☐	General social challenges		☒	☐
	☐	Absence of services		☐	☐
	☐	Absence of eldercare		☐	☐
	☐	Absence of educational services		☐	☐
	☐	Flooding		☐	☐
	☐	Drought		☐	☐
	☐	Brownfield presence		☒	☐
	☐	Absence of funding		☐	☐
	☐	Absence of people participation on social life and civic engagement		☐	☐
	☐	Heat waves		☒	☐
	☐	Heat island		☐	☐
	☐	Food shortage		☐	☐
	☐	Water shortage		☒	☐
	☐	Dis-comfort outdoor		☒	☐
	☐	Absence of spaces for sociality and of play grounds for children		☒	☐
	☐	Dis-comfort indoor buildings		☐	☒
	☐	High building energy consumption		☐	☒
	☐	Absence of low mobility and green mobility		☐	☐
	☐	Absence of efficient and sustainable public mobility		☐	☐

Scenario 1 focuses mainly on built environment interventions. As described by the municipality in (Comune di Bologna, 2013), the buildings' sector is one of the most energy consuming. In particular, the following actions are envisaged for achieving the selected target:

- Improving the energy performance of buildings façades and outer shell (façades, roofs) by:
    - Adding external or internal insulation
    - Substituting windows with more performing ones
    - Improving the water collection / slowdown with green roofs or green façades
- Improving lighting with the implementation of LED systems (at first for common spaces, then also for private spaces)
- Improving heating and cooling systems' efficiency by:
    - Removing old boilers and installing new centralized ones.
    - Implementing monitoring systems for each unit with the possibility of installing control systems able to interact directly with the heating system (NEST)
- Implementing local energy production with:

- Installation of PV panels and solar thermal panels
- Testing of TESLA batteries for electric storage in some units.

The main goal for this scenario is to fight against fuel poverty and to meet some of the energy performance targets. These actions can be at first implemented into the public owned building stock. This building stock is mainly composed by buildings built in the 50's, which have important problems on energy efficiency and indoor comfort both during winter and summer. This discomfort and high-energy consumption leads to several episodes of fuel poverty, because

Figure 5.18 Scenario 1. Scheme of the strategy

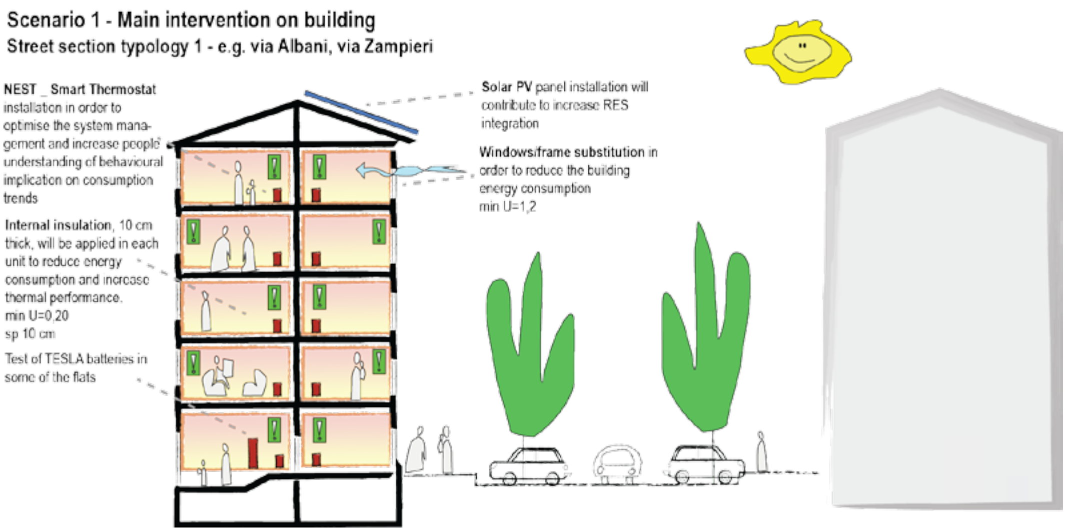


Figure 5.19 Preliminary analysis and scenario 1 spider graph

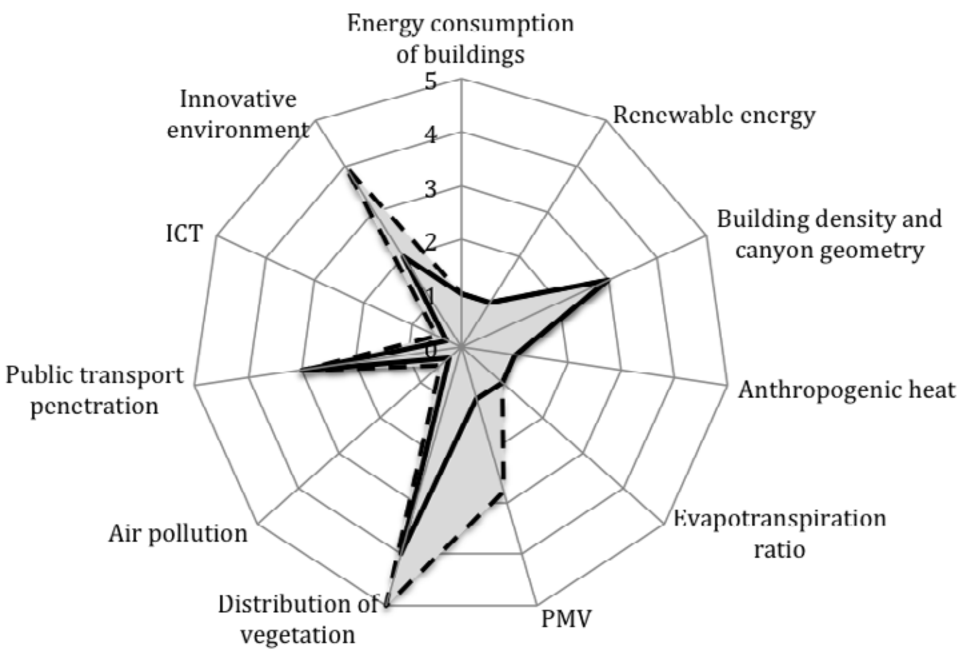


Figure 5.20 Scenario 2. Scheme of the strategy

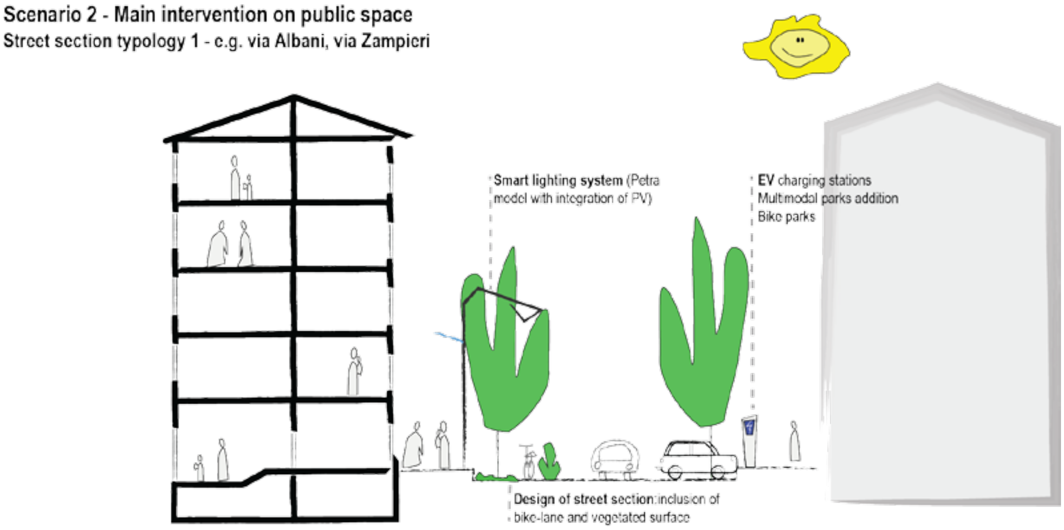


Table 5. 5 Main buildings data

Year of construction	**1950-1955**
Building tipology	Concrete Buildings with courtyard. The structure is composed by concrete pillars and infill wall in masonry.
Thermal situation	The thermal situation is very poor. The buildings doesn't have an insulation or performant windows. The buildings need an important energetic expense during winter for heating and summer for cooling.
Energetic production situation	Buildings have single boilers for the heating and single refrigerating units. No renewables present.
Decay situation	The façades need a retrofitting as well as the internal layout, not responding to families' needs.
Analysis of the existing	All the buildings have an energetic consumption estimated higher than 210 kWh/m^2/year (data from energy certification).
Passive systems	Buildings don't present specific passive systems: they have some natural shadowing gave by balconies, and some natural gains gave by traditional windows. But those systems are not incident into the energy performance of the buildings.
Active systems	No active systems present, except from the traditional heating and cooling systems.
Embodied technologies	No technologies present.
Microclima related actions	The Envimet analysis shows some important characteristics for the micro-clima analysis of this part of the district. In particular, the presence of hot air temperature near the boundary linked with the train station and in some internal part of the district. Also the relative humidity is high in some internal part of the district. But, in general the condition of the neighborhood are not so uncomfortable. This is probably due to the big presence of trees and grass into the courtyards and along the streets.
General info on grid technologies and lighting	The district has no electric smart grid, but traditional one. Also the lighting is traditional and not so performant.
General info on mobility and services	The passive mobility (bikes and pedestrian access) is not taken under control with specific access or reserved areas. The active one, in term of EV ore innovative systems, is not present.

of which people are not able to face energy bills. A scheme of actions that can be implemented into this building stock is visualized in figure 5.18.

In respect with the described actions and as done for the preliminary analysis, each indicator is evaluated and re-calculated as described following. The calculation is based on one sample selected building, located in via di Vincenzo. The reason is that all ACER buildings are uniform in term of energy consumption and in term of average surface and weight: they are 5 floors tall, which homogeneous construction technique (load bearing walls in brick, without insulation). For these buildings, ACER and the municipality made different data available. As a consequence the application of the GCC and, in particular, of built environment interventions is located into these stock of buildings, for which data are present. There are two groups of homogeneous buildings for which there are several data:

Table 5. 6 Scenario 1: KPI calculation

Indicator	Reflexions and actions	Previous	New	Score
1. Energy consumption of buildings	A calculation by using Termolog software is made considering the installation of insulation + thermostats + PV panels + boiler substitution + solar thermal production. 63,99 kWh/m^{2}y is equivalent to an improvement of 30 % for heating.	210 kWh/m^{2}y	33 kWh/m^{2}y	4
2. Percentage of RES	Using a tool for simulation it is possible to rapidly assess that installing a PV system with a surface of 250 m^2, 25 kW installed, the production is almost 70,000 kWh/y. The surface of the sample building is 2150 m^2, so the reduction is almost 100% (the electric request for common parts is 10,000 kWh/y). In absence of single bills (which are protected by the privacy legislation) it is reasonable to affirm that the electric need can be covered at 100% for electricity. With the same calculation, it is possible to highlight the total available surface of roofs into the selected area, which is almost 45,000 m^2. Implementing also RES for heating production (e.g. with biomass or heat pumps) it is possible to meet a range of 60-80% of total energy needed provided by renewables.	< 19%	80%	3
3. Building density and canyon geometry	Density	4,43 m^3/m^2		3
	Sky View Factor	ND		
	Canyon geometry	1		
	Qualitative analysis	0,25 (trees)		
		0,25 (cycle path)		
		0,25 (access)		
		0,25 (street lighting)		
5. Anthropogenic heat	With thermal insulation it is possible to calculate again the anthropogenic heat due to buildings' walls. Considering the Uwall= 0,19 W/m^{2}K, the expression gives a result of 2,8 W/m^2	< 9 W/m^2	2,8 W/m^2	5

5. Evapotranspiration ratio	The evapotranspiration ratio is not affected by the project. If green roofs are installed it will be affected.	89%	89%	1
6. PMV – Thermal comfort	8:00	-0.21 / 0.91		2,8
	10:00	1.23 / 1.98		
	13:00	2.12 / 3.71		
	16:00	2.51 / 3.91		
	19:00	2.70 / 4.46		
7. Distribution of vegetation	The distribution of vegetation is not affected by the project.	More than 50% of streets have linear trees distribution		4
		More than 50% of open spaces have wooden trees distribution		
8. Air pollution	It is reasonable to say that the air can benefit from the improvement of the built environment. The installation of PV panels e.g. gives a saving of almost 12,000 kg CO2e. To have a precise calculation a LCA calculation is needed.	ND	ND	0
9. Green public transport penetration	Radius distance among buildings and multimodal parking <500 m	< 500 m		3
	Radius distance among buildings and normal bus stops <200 m	< 200 m		
	Presence of parks for bike sharing or car sharing	2		
10. ICT devices	Installation of monitoring devices	ND	1	3
	Installation of energy management systems		1	
	Installation of automated devices (acting on the heating system)		1	
11. Innovation environment	Presence of living lab	1		4
	Presence of artists	1		
	Presence of associations active on the community	1		
	Presence of participative approach	1		

1) Group 1: 3 ACER buildings where no interventions were already done and where the main strategy is located. This are placed in via Tibaldi 40-40/2; via Albani 16-18-23-21; via di Vincenzo 27-25. The total units considered are 85.

2) Group 2: ACER Buildings object of the RIG.ENER.A project. These are 6 buildings with a total of 249 units. In these buildings are envisaged additional interventions for testing specific innovative solutions.

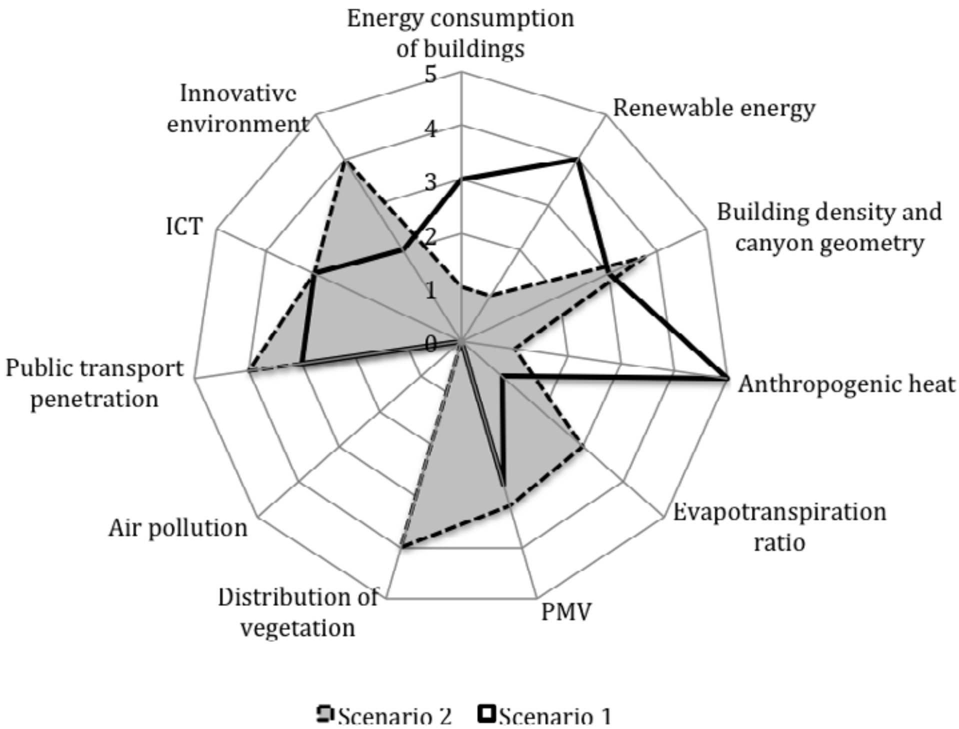
Some more information about the state of the art of those buildings are provided in the table 5.5.

As a result of this evaluation, the spider graph in figure 5.19 can be visualized.

Scenario 2

Scenario 2 focuses mainly on open space interventions, with the aim to

Figure 5.21 Scenario 1 and scenario 2 spider graph



operate into the mitigation of climate change and for avoinding flooding and heat waves.

The following actions can be envisaged for meeting those goals:

- Improving the permeability of the district by adding vegetation, trees (species able to reduce air pollution and to resist to climate change), water surfaces, rain gardens. This action can be held in collaboration with the idea of implementing spaces for community and playgrounds.
- Improving bike and pedestrian lanes in main streets, also by reducing car lanes
- Adding a multimodal park inside the district for freeing the ground space as much as possible by cars
- Improving street lighting using innovative systems, e.g. including WiFi hotspots, PV panels and sensors for outdoor monitoring (e.g. Petra model[11]).
- Improving the market area and the courtyards as main social spaces by improving the outdoor comfort.
- Improving waste management with smart bins installation in streets (e.g.

11 See also: http://www.petrasystems.com/intelligent-operations/

Table 5. 7 Scenario 2: KPI calculation

Indicator	**Reflexions and actions**	**Previous**	**New**	**Score**
1. Energy consumption of buildings	Energy consumption of buildings will not be directly affected by the selected actions.	210 kWh/ m^2y	210 kWh/ m^2y	1
2. Percentage of RES	Percentage of RES will not be effectively affected by the selected actions, even if it is possible to have improving for covering the energy needs from street lighting. Even if the energy for street lighting could be covered in 100%, the general energetic need will not be so much affected.	< 19%	< 19%	1
3. Building density and canyon geometry	Density	4,43 m^3/m^2		3,75
	Sky View Factor	ND		
	Canyon geometry	1		
	Qualitative analysis:	0,50 (trees)		
		0,50 (continuous green surfaces)		
		0,25 (unimpeded sidewalks)		
		0,25 (cycle path)		
		0,25 (access)		
		0,25 garbage and community services		
		0,25 street furniture		
		0,25 flux clear separation		
		0,25 (street lighting)		
5. Anthropogenic heat	The anthropogenic heat will not affected in the part of walls heat in this selection of actions. Nevertheless, it will be possible to monitor the anthropogenic heat improvement coming from the reduction of traffic.	< 9 W/m^2	< 9 W/m^2	1
5. Evapotranspiration ratio	The evapotranspiration ratio will be affected by the project, as green surface will be implemented in several ways.	89%	40%	3
6. PMV – Thermal comfort (vedi nuova licenza software)	8:00	-0.18 / 0.99		3,2
	10:00	1.26 / 2.01		
	14:00	2.13 / 2.91		
	16:00	2.50 / 3.43		
	19:00	2.43 / 4.46		
7. Distribution of vegetation	The distribution of vegetation is already good into the district.	More than 50% of streets have linear trees distribution		4
		More than 50% of open spaces have wooden trees distribution		
8. Air pollution	It is reasonable to say that the air can benefit from the improvement of the open spaces with trees and green surfaces. Nevertheless it is necessary to have data from sensors to assess the benefits. In general it is expected an average benefit of 22kg CO2e saved per tree per year.	ND	ND	0

9. Green public transport penetration	Radius distance among buildings and multimodal parking <500 m	< 500 m		4
	Radius distance among buildings and normal bus stops <200 m	< 200 m		
	Presence of parks for bike sharing or car sharing	2		
	Presence of permeable parks	1		
10. ICT devices	Installation of monitoring devices	ND	1	3
	Installation of energy management systems		1	
	Installation of automated devices (acting on traffic and extreme events)		1	
11. Innovation environment	Presence of living lab	1		4
	Presence of artists	1		
	Presence of associations active on the community	1		
	Presence of participative approach	1		

Big Belly Solar model[12]).

- Implementing EV fleet for common use.

As a result of this scenario, the spider graph on figure 5.21 can be visualized.

5.2.3 Step 4 and 5: implementation plan

The two scenarios, described in the previous section, are useful for reflecting on several sectors of interventions, taken singularly. Nevertheless, as assessed into the first section, a GC is not only about having a panel of actions, but also having a cross-sectorial approach aiming to meet different challenges, having a strategy for involving stakeholders and citizens, having a timing for the implementation of different actions. Finally, having a business idea for funding the whole strategy.

In the case of Bolognina, it appears clear that the best scenario is the composition of the two described above. For example it is possible to select actions having the best impact on the general goals. In that case the general master plan of action that is here suggested is composed by the several actions as described in table 5.8. The table reports a selection of actions, the calculated target to achieve, which is the general goal and the expected costs. This last element is not assessed with real budget (which is dependent of a specific market analysis), but briefly reminded with symbols:

12 See also: http://bigbelly.com/

Table 5. 8 Expected cost evaluation

Action	**Place of application**	**General goal to achieve**	**Expected cost**
1. Boiler substitution	Group 1	Bills / Energy consumption reduction	€€€ [1]
2. Monitoring (NEST) installation	Group 1+2	Monitoring energy use inside buildings	€€ [2]
3. PV panels on public buildings	Public buildings	Improve local energy production	€€€€ [3]
5. Green implementation and improvement of courtyards quality (rainfall gardens, playgrounds)	Open space	Improve evapotranspiration and reduce impervious surfaces	€ [4]
5. Improvement of the market area (quality, green, etc)	Market area in via Albani	Improve social space and reduce impervious surfaces	€ [5]
6. Smart bins installation with solar production	Open space	Improving district quality and waste management	€€€ [6]
7. Implementing street lighting with sensors	Open space	Monitoring air quality, traffic and outdoor comfort + improving sense of safety	€€€ [7]
8. Implementing insulation and windows substitution on residential buildings	Group 1	Bills / Energy consumption reduction	€€€€ [8]
9. PV panels and solar thermal panels on residential buildings	Group 1	Improve local energy production	€ [9]
10. TESLA piloting implementation in some units (10 piloting units)	Group 1	Improve local energy production and storage	€€ [10]
11. Implementation of LED lighting inside buildings (in each unit)	Group 1+2	Bills / Energy consumption reduction	€€ [11]
12. Implementation of a multimodal park	Open space	Improving district quality and freeing ground space from car	€€€€
13. Redefinition of street sections with implementation of bike lanes	Open space	Making the use of bike more comfortable	€€
15. EV fleet for common use	Open space	Energy consumption reduction and freeing ground space from fuelled car	€€€ [12]

1 - Considering 2-4,000 €/units x 85 units = 170,000 – 340,000 €
2 - Considering 250 € / units x 334 units = 83,500 €
3 - Considering an available public surface on roofs of 11,000 m^2, and the installation of PV park of 200 kWp, with a cost of 4,200 €/kWp the total could be about 840,000 €
4 - For this element, it is considered a flat rate of 50,000 € coming from the visualization of different business plans in different Italian cities.
5 - Also for this element, it is considered a flat rate of 50,000 €.
6 - Considering 4,000 €/bin x 100 bins = 400,000 € (Culgin, Mangan, & Pool, 2013)
7 - For now no data were available on the cost.
8 - Considering 80-100 €/m^2 (x 3500 m^2) for insulations and façades improvement + 290 €/m^2 (x 850 m^2) for windows replacement (aluminium-wood with thermal break) = 280,000 – 350,000 € (façades) + 246,500 € (windows) = 596,500 €
9 - Considering a system of 20 kW x 2000 €/kW = 40,000 €
10 - Considering 7,000 €/battery x 10 piloting units = 70,000 €
11 - Considering 10 €/lamp and an average of 40 lamps / units = 400 €/units x 249 units = 99,600 €. The implementation of Led lamp only in common spaces could cost an average of 50 €/lamp (using more powerfull lamps also for outside) x 20 lamps / buildings = 1000 € / building x 3 building = 3,000 €
12 - Considering 30,000 €/car and a fleet of 10 cars for the piloting action = 300,000 €

- € indicates a low-cost action (<50,000 €)
- €€ indicates a medium-cost action (50,000 € < x < 100,000 €)
- €€€ indicates an expensive action (100,000 € < x < 500,000 €)
- €€€€ indicates a very expensive action (>500,000 €)

Notice that this analysis is not to be intended as a budgeting analysis, but as framework for having a general idea on average costs of actions.

After having defined main actions, targets and having reflected about the expected costs, the application considers which are the main stakeholders to be involved (and how) and the timing. As for expected costs, timing is evaluated determining what actions can trigger chain reactions. Some symbols are also used: < for indicating a first action; > for indicating a secondary action (table 5.9).

A participative strategy is also needed for really involving the community. Into this specific context, as there are already active artistic associations and living labs, it is possible to exploit them for making the communication and the participation more effective (table 5.10).

A general timing strategy is also provided (as hypothetical framework) in table 5.11.

Finally, a scheme of a possible innovative business strategy is provided in figure 5.22. The objective was to try to include a circular economy prospect, in order to make all strategies feasible, also on the economic point of view. The

Figure 5.22 Bolognina pilot circular economy scheme

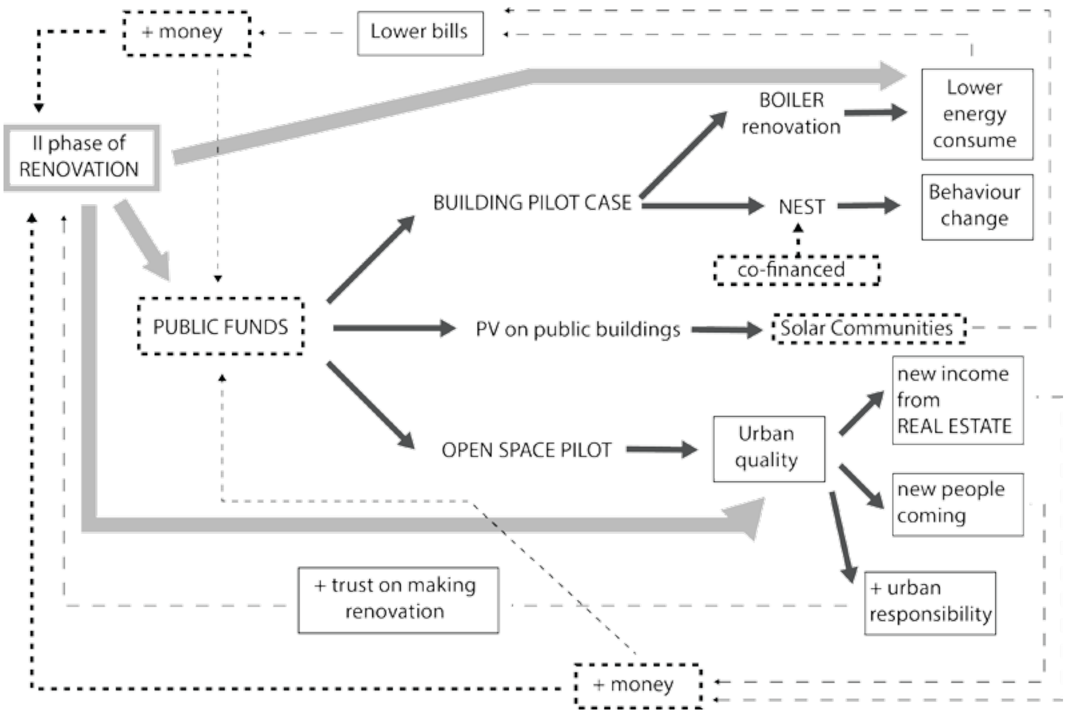


Table 5. 9 Stakeholders and citizens partecipation on selected actions

Action	Stakeholders	Involvement of citizens	Timing
1. Boiler substitution	- Property: municipality - Management: ACER - Provider of system (Esco) - Energy provider - Citizens (residential)	Action: Communication/branding Event: community barbecue (with training)	<
2. Monitoring (NEST) installation	- Property: municipality - Management: ACER - Provider of system (Esco) - Energy provider - University (research and monitoring) - Citizens (residential)	Action: Communication/branding Event: community barbecue (with training)	<
3. PV panels on public buildings	- Property: municipality + other associations inside the buildings - Management: ACER - Provider of system (Esco) - Energy provider - Citizens (residential + workers)	Action: Communication/branding Event: community barbecue Circular economy: Solar Community	<
5. Green implementation and improvement of courtyards quality (rainfall gardens, playgrounds)	- Municipality - District association - Cultural associations (living labs, artists, etc) - Provider of renovation -University (for research and monitoring) - Citizens (residential + workers)	Action: Working group for ideation Events: street art festival + food festival	<
5. Improvement of the market area (quality, green, etc)	- Municipality - District association - Workers on the market - Cultural associations (living labs, artists, etc) - Provider of renovation -University (for ideation, research and monitoring)	Actions: working groups + daily selling of food for people working in the area (e.g. sandwiches) Events: exhibitions + food festival + monthly implementation of the market along via Fioravanti (to involve all the community present inside the district)	<
6. Smart bins installation with solar production	- Municipality - District association - Cultural associations (living labs, artists, etc) - Provider -University (for research and monitoring) - Citizens (residential + workers)	Events: Street art festival	>

Table 5.10 Participation and citizens involvement strategy

Strategy	Frequency	Objective
0. Web page of the project + app	-	Communicate and collect feedbacks from citizens.
1. Working group / Workshop with students, citizens, municipality and stakeholders	1 per year for the duration of the project (3-5 years) or every time important ideation sessions are needed	Making citizens involved into the ideation process. One instrument, given as example, for making these working groups effective, is the Ruphopoly game1.
2. District/courtyard barbecue	1-2 per year in correspondence of main installations	Building the community and in the same time make the building renovation results an event / a party, in order also to demonstrate the functionalities of devices installed or of the general strategy. These barbecues can be organized one per courtyard in order to build the community inside their daily life.
3. Street Art Festival	1 per year from the 1st year	Building the community at the district level with the involvement of living labs into the organisation and of independent artists, already present into the context. This is the occasion for showing important results on the open space renovation
5. Food Festival	1 per year from the 2nd year	Building the community at the district and general urban level. The city of Bologna is known for the excellence of food. Making a festival based on food inside Bolognina will develop a sense of inclusion into the city dynamics. The presence of the new City Hall makes the area perfect for this objective.
5. Market in via Albani	Daily market (already active) Extension in via Fioravanti 1 per month	Building the community among resident and municipality workers, as well as increasing the economic potentiality of the market in via Albani.
6. EV and bikes festival	Once after 3-4 years of project	In concomitance with the installation of the EV fleet for community use, a big EV and bike festival can be organized. It could be incentrated on green mobility system, with the organisation e.g. of a marathon starting and finishing in front of the City Hall, of a EV cars race, etc.

1 This is a role game developed by the University of Birmingham, to foster the participation of citizens and stakeholders into the decision-making process about a district or a city. See: http://www.bcu.ac.uk/research/-centres-of-excellence/centre-for-environment-and-society/projects/rufopoly/project-details

strategy starts from public investments, which can comes from EU/regional fund, urban budget allocations and PPP. The strategy creates a return of investment due to energy savings and the consequent lowering of bills. The first scheme puts in evidence how the return in investment is intended, while the second scheme puts in evidence the circular process.

The monitoring and the evaluation is important for each strategy implementation, because it makes possible to adapt the strategy in itself during the process or to learn from it after the conclusion. For making this possible it is necessary to define a set of monitoring indicators and the definition of milestones (table 5.12).

Table 5. 11 Timing framework scheme 2018-2021

Actions / Time	**2018**				**2018**				**2019**				**2021**			
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
1		T			B											
2		T			B											
3							B									
4		T					B									
5	T															
6													F			
7									F							
8													F			FF
9													F			
10										B						
11										B						
12																FF
13												T				FF
14																FF

Timing framework from 2018 to 2021. T=training activity; B=barbecues; F=festival; FF=final festival

In this table an example of monitoring indicators and milestones is provided for the strategy proposed for Bolognina district. As each project has specificities and unique actions, each strategy needs to select its own monitoring indicators. The table is needed for monitoring, in different moments, the state of achievement of selected targets. Two milestones are expected at M18 and M36. Milestones are moment of reflection, where the project is evaluated and if some barriers or problems are occurring, it is still possible to overcome them, by using mitigation measures.

Some barriers can occur during the life of the project. In table 5.13, some of them are highlighted.

Table 5. 12 Bolognina pilot: target development and evaluation moment definition

Monitoring KPI	Unit of measure	Target at M48	M12	M24	M36
1. Energy consumption of building	kWh/m^{2}y	< 50			
2. Participation in barbecues events	n° of people	> 10			
3. Participation in festivals	n° of people	> 100			
5. Behaviour changes after NEST installation (decrease of bills cost)	€ (decrease in bills costs)	< 20			
5. Participation in working groups	n° of people	> 10			
6. Positive feedback on questionnaires	n° of people	> 50			
7. New people (students or other residents) coming inside the district	n° of people	> 30			
8. Opening of new services / businesses / workers on the market	n° of people	> 5			
9. Effectiveness of market extension	n° of people	> 50			
10. New subscription in Local Solar Community	n° of people	> 10			
11. Bike use instead of cars	n° of people	> 50			
12. Use of sharing mobility	n° of people	> 20			
13. Readiness to unexpected events	n° of days of defaulted emergencies	< 1			
15. Fuel poverty resolution	n° of families still not using heating systems in winter	< 5			
15. Flooding occurrence	n° of events	= 0			
16. Heat waves resolution	n° of days with heat waves	< 2			

Table 5. 13 Bolognina pilot: risk evaluation

Risk description	Likelihood	Severity	Contingency action
1. Low citizens' participation	Medium	High	To find new solutions for making people participating (branding, new events, better communication, etc.)
2. Lack of funding coming from PPP (stakeholders)	Medium	High	To find new stakeholders interested into the process. To explain and reflect better on paybacks To reflect on image payback
3. Technical problems in systems	Low	Low	-
5. Monitoring problems (absence of data or data not relevant)	Low	Low	-
5. Change in political commitment	Low	High	To communicate the project to the new political framework as a potential for improving the image of the city, lifestyles and healthcare, but also for improving economy. To re-address some strategies in order to meet the eventual new targets.

Conclusions of Section 2

The application of the GCC into the real context of Bolognina district, puts in evidence several elements:

1) the model can be applied into a real context and it is useful for the definition of a concrete strategy aiming to meet specific targets;

2) the model guides a reflection on targets, barriers, timing and businesses;

3) Bolognina district has several potentialities in order to meet the transition toward low carbon, but a process involving public and private funds, as well as the deep participation of citizens as prosumers is needed.

Guidelines for resilient, smart and sustainable Bolognina district design

The simulation on Bolognina district made possible to define some guidelines for the municipality. The aim of these guidelines is to focus on some key points in order to accelerate the transition of the district toward low carbon. They can be resumed as following:

1) **Actions for improving resilience**. Municipality already has a great attention on resilience inside the whole city. Following this criteria, inside the Bolognina district it is perceived the need of improving the quality of open spaces through the qualitative presence of green elements aiming to reduce impervious surfaces. Space in-between buildings can be improved also on the social perspective by implementing services and facilities (e.g. light, waste and water management).

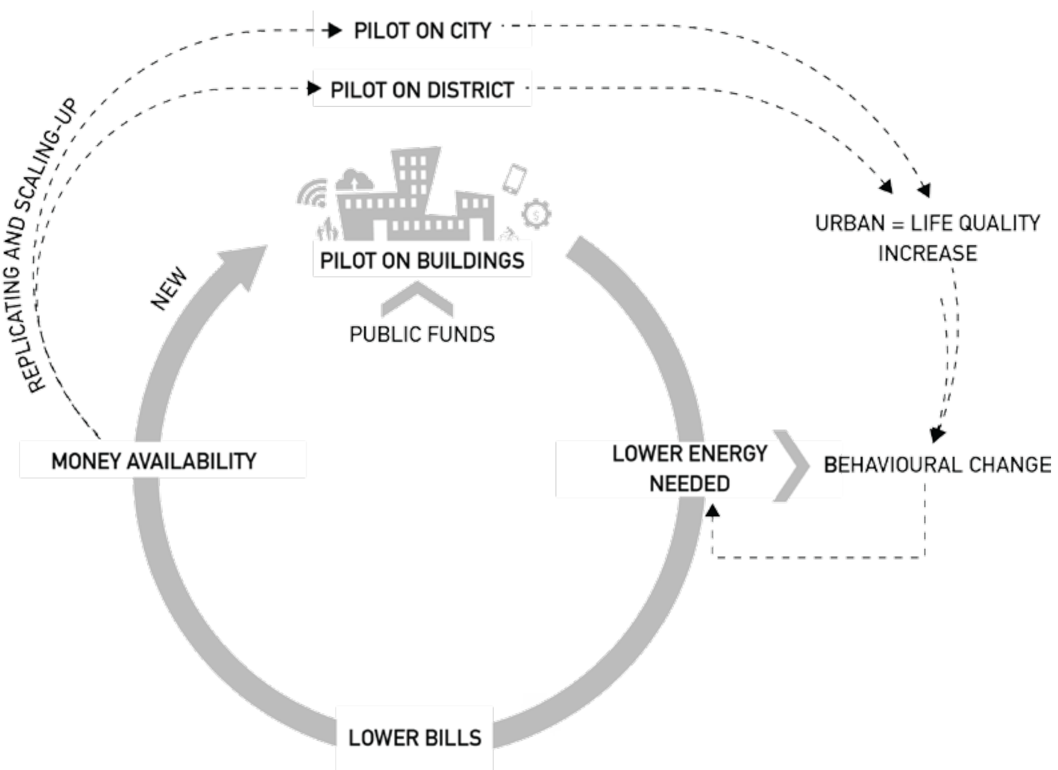
2) **Actions for built environment energy efficiency improvement**. Even if some activities and projects in the field of energy efficiency are already present into the district (e.g. project Rigenera), it is perceived the necessity of mapping the whole built environment energy performances, starting from buildings, but also considering public lighting and mobility. There is, in fact, the necessity to increase the knowledge not only about few buildings, but about the whole built

environment system, in order to frame a more efficient plan of investments and actions. In particular, it is considered interesting to follow the strategy of making Energy Perfomance Contracts with the inclusion of Escos and citizens' societies as major stakeholders.

3) **Actions for citizens involvement**. Several activities have been developed inside the district and in the whole city for increasing citizen's participation. However, it is perceived the necessity of fostering this effort, by creating interest into public management of spaces and communities. Inside the Bolognina district, in particular, the potentialities given by the presence of several cultures, courtyards are identitary spaces, the market and the proximity with new urban development need to be seized and framed under a common vision. A deep analysis on social perspective is recommended, with the use of recent strategies, such as the Participative observation.

Replication of the strategy into the metropolitan area of Bologna and in Europe

Figure 5 .24 Bolognina pilot scaling up scheme



The city of Bologna has several interesting districts, inside its municipal territory, where the GCC model can be applied with the aim of triggering changes. The aim of guiding cities into a transition toward green and integrated system could be achieved by applying successful projects into different districts of the city. The idea is far from thinking that the sum of detached projects on detached districts can make cities greener and smarter, but more that integrating actions into a coordinated system of particular districts of the city can accelerate this transition and, overall, can trigger the creation of circular positive processes. Districts where strategies are applied need to have big potentialities of change, e.g. because of the presence of a training cultural heritage, or the presence of a training community, or again the presence of transformations on-going.

Into the city of Bologna, for example, there are several interesting districts answering these requests, where the GCC model can be replicated. However replication of strategies can pose several problems:

1) A 1:1 replication is not possible in term of actions and projects because each context, even inside the same city, has its own specific challenges.

2) It is important to consider the replication as a way for reflecting on new context and learning more about the city and its general challenges and constraints.

3) Some key points need to be taken into account: i) replication means to re-apply from the beginning the whole strategy, not only actions; ii) a new political commitment with stakeholders involvement and budgeting financing is needed for each new district; iii) it is important to have a urban general strategy underlying all the implementation. The approach needs in fact to be multi-layers, multi-stakeholders and multi-disciplinary and balanced.

Hence, three interesting districts can be selected into the city of Bologna, having potentialities for triggering interesting processes: the exhibition area, the Piazza Verdi area and Staveco area. The first one is the area of Exhibition, which is located in the north part of the city. This is a mixed used area where the Exhibition site occupies a very big portion of territory (375,000 m^2). The potentialities gave by the extension and the international importance of that area, candidate the site for being a potential piloting area for testing innovative solutions.

The second one is the area of Staveco, which is located in the south part of the city. This is a big brownfield located near one of the biggest urban garden of the city: the Margherita Garden. Here lot of developments are on-going: inside the park some innovative social and economic experiences are going on, as the start-up incubator named Le Serre. Staveco is a brownfield, object of big interests from the municipality, and for which a project was already proposed with the collaboration of the University, for creating a new University pole. The potentialities gave by the extension and by the strategic position of that area, candidate the site for being a potential great example of smart initiatives.

Finally, the third district can be the central area of Piazza Verdi and via Zamboni, which is located in the centre of the city, inside the historical district. This is the context where lot of universities buildings and cultural heritage is present. The potentialities gave by the extension and the strategic position of that area, candidate the site for being a potential great example of piloting area for smart initiatives.

Except form the application of the GCC model inside the selected district in Bologna (which can be done in future researches), it is possible to argue about replication potential of the model in European cities. As a general frame, the GCC model can be applied everywhere, as it is intended to be an instrument for designing strategies. However, several barriers can occur, for example legislation barriers, stakeholder involvement, differences in PA processes, etc.

DISCUSSION

The discussion chapter gives a conclusion to the study by summarising the major research findings in respect with research questions, aims and objectives. Furthermore, this chapter presents a reflection upon the replication of the model and the integration with the current Italian regulatory framework. Then it also provides recommendations for further research.

Research findings

The main purpose of this study was to investigate and identify main constitutive and successful elements of a SC, in order to understand if this spread and worldwide used approach could meet the actual pressing challenges that cities are facing. In order to meet this aim, three major objectives were developed. The first objective was to identify successful elements of SC by analysing theories and real practises. The second objective was to develop a set of indicators in order to define the new urban requirements within urban areas on a district/ neighbourhood level. The third objective was to draw a model for addressing the regeneration of the built environment, based on scenarios and KPIs. In light of the research aim and objectives, the following research questions were addressed in this study:

Assuming the relevance acquired by SCs inside urban policies all around the world, can Smart City Strategies really meet actual challenges that cities need to face?

The literature review has shown how SC originates from a debate questioning about the future of cities in a world continuously object of pressures from resource scarcity, economic crisis, lack of social identity and besides continuous input from technologies. The progressive permeating of innovative devices, simplifying people life or enabling them in networking and knowledge, led to relevant modification of the built environment, in order to make cities able to use those technologies (it is an example of this the installation of WiFi repeaters, networks, etc: see 1.2.3 Cities technological infrastructure, p. 83). Scientists from the end of the previous century started to argue about digital cities, where everything would have been possible without moving from one place to another and where real physical space would have been freed only for social interactions. From then the debate evolved mainly caused by the awareness about the weight of human fuel-based economy on Earth and the reflections about climate change. Today the relevance of SC is still high and it seems that technologies (mainly ICT but also other) are definitively part of the built environment. Furthermore, several experiences showed how those systems can really improve the management of urban context -e.g. with data collection and mining, which gives an increased knowledge on building performances, people movements, etc.- and optimise resource consumption. Hence, studies ongoing in several disciplines seems to prove that technologies can be really applied on each level of urban systems and that they can give some positive impacts. Nevertheless, it seems also clear how not any kind of devices really help cities in creating better place for living, but technologies must be addressed for solving specific challenges framed by a strategic vision of cities future, with clear and precise objectives. To sum up, the answer to the research question could be positive but only if devices and technologies are framed on a clear vision for each context of application. The research, in fact, decided to go beyond boundaries given by the definition of SC, toward a wider and more inclusive definition of green cities, which it is intended to include resilience, smartness, sustainability as major objectives to achieve with urban projects (see chapter 1, 2 and 3).

What are the main successful elements of a SC approach?

The analysis of best practises and the literature review put in evidence some main successful elements composing a SC (see chapter 2). They can be summarized as following:

- presence of a clear vision, which must be specific on each context, time-related and targeted to major long-term objectives;
- the vision must targets not only specific challenges but also general world ones, such as climate change, social inclusion, etc., as defined by Europe and United Nations;
- the process must involve a wide number of stakeholders, included citizens;
- ICT solutions can improve the completion of results and accelerate the

process but it doesn't mean that they are necessary everywhere and every time; technologies and ICT must be related to the strategy, with cost-effective and sustainable perspective;

• solutions meeting more than one challenge are more successful and sustainable on the economic and management point of view;

• the importance of taking into high account local context is fundamental, in order to create triggering environment for future development.

What are the new requirements complex urban contexts need to meet?

The analysis of best practises and the reflection upon KPIs highlighted some additional requirement that complex urban environment seems to show, in respect to traditional ones. In fact, current practises seem to evidence the emerging of requirements answering new challenges. Among them the most relevant seems to be: wellbeing, security, usability and accessibility, integrability, sustainability and fight against resource depletion, resilience, interoperability among units, monitoring and automation (see chapter 3).

How is it possible to measure and evaluate performances of SC strategies into a long term perspective?

Chapter 3 analyses some actual existing processes and assessment models. On the basis of the finding of this research, the thesis outlined a new set of KPIs related to a Green integrated cities approach (see chapter 4).

Finally, how can a new smart approach be developed to accelerate the transition of cities toward more inclusive, sustainable, green and smart systems?

After having analysed several components of SC approaches a new model have been proposed by this research with the aim of addressing the regeneration of the existing built environment, on a district/neighbourhood level. The model is developed in several step outlining different phases of the process: analysis of the state of the art (through the use of KPIs), selection of targets, definition of scenarios and selection of the most suitable one for the context of application, definition of business models and timing approach, definition of a monitoring and evaluation approach.

Integration of the GCC model into the italian urban regulatory system

The actual urban planning system is complex and composed by several levels. In fact, the Italian legislation framework about territorial and urban planning is divided into several instruments. Without going into many details about urbanism and urban planning system, it is possible to generalize the main framework in different levels of urban instruments: a national and regional level, which gives the guidance for a general territorial strategy and specification about cross-regional or national aspects; a territorial level including general instruments -such as the Regional Territorial Plan (= Piano Territoriale Regionale - PTR) or the Territorial Plan of Provincial Coordination (= Piano Territoriale di Coordinamento Provinciale – PTCP)- and sectorial instruments –such as the Landscape Plan (= Piano Paesaggistico); the municipal level which design regulation instruments for the municipal territory, such as the General Regulatory Plan (= Piano Regolatore Generale – PRG) or the Municipal Urban Plan (= Piano Urbanistico Comunale = PUC) or, as in the case of Bologna, the new Strategic Municipal Plan (= Piano Strategico Comunale); and finally a scope level, addressing specific areas into the municipal. Scope instruments are for example the Detailed Plan (= Piano Particolareggiato - PP), the Plan for Social Housing (= Piano Edilizia Economica e Popolare – PEEP), the new Regeneration Plan (= Piano di Recupero). Besides there is a group of programs which also intervene for specific aspects of territorial modification, for example the Urban Renewal Program (= Programma di Recupero Urbano) or the new Urban Regeneration and Sustainable Development Program (= Programma di Riqualificazione urbana e di sviluppo sostenibile del territorio – PRUSST). Besides there is also another instrument called Districts contracts (= Contratti di Quartiere), which are particular as they are regeneration plans co-financed by the State and the region, promoting the regeneration of particularly problematic and challenging portions of a city (they could be a district, but also a block house or a square).

In Bologna the main territorial and municipal strategy is solved by three major plans, which are the PSC – Strategic Municipal Plan (which is seeing actually the new draft of an additional and integrated Metropolitan Plan); the RUE – Urban Building Regulation, which regulates all physical transformations; and finally the POC – Operative Municipal Plan, which is the operative instruments for addressing changes and modifications. Besides there is the Territory Unitary Map (= Carta Unica del Territorio) which identifies the constraints systems. Some Districts contracts are also ongoing in two different portion of the city and in particular on a block house of 3 buildings inside Bolognina Neighbourhood and on a block house of 6 buildings inside San Donato neighbourhood.

Into this complex context, the proposed GCC model aims to simplify the design of the territory by acting in collaboration with the actual existing instruments. In fact, the model can help address urban challenges in different levels of regulation, in dependence of which are the target group using the model in itself. Hence, the GCC model can be used on two main different levels, having different functions and users:

• Address function. This is the most interesting use of the model, as it could enter into the definition of the general strategy upon an urban area. In this case the regulatory level could be in correspondence with the definition both of the Municipal Strategic Plan or of different scope plans acting on portions of the city (e.g. in correspondence of Districts contracts or Regeneration Programs applied on a district, or again Operative Municipal Plan bound on a district). In this case decision makers or municipal architects/professionals are the users of the model.

• Project function. This could also be one of the possible use of the GCC model, as it could enters after the design or the regulatory and plan framework, in order to help architects acting inside a district, both with a big project, involving all dimensions of the district, or with smaller projects involving parts of the district (which could be buildings or streets or energy networks, etc.).

It is opinion of the research that the most effective and interesting level for using the GCC model is the first one, as the model in itself has been designed in order to accelerate and help the definition of holistic strategies for districts and neighbourhood aiming to achieve the complete transition toward low-carbon, green and smart complex systems. In fact the model aims at expressing a strategic plan on a district, able to guide the complex system of public and private funds and of actions, detecting priorities and coordinating specific actions into a complete, cost-effective and inclusive urban project.

As an example of this, Figure 6.1 and 6.2 identifies two possible coordination of GCC with the plans system.

Implication of the research and recommendation for further researches

The results of this study have shown that the GCC model can provide guidance in assisting developers, planners and policy-makers to address holistic strategies at the district level by capturing pressures and driving forces in urban areas and targeting some of the main world pressures (climate change, resilience, fight against fuel poverty, etc.).

However, like other models, the GCC model has both strengths and limitations. The strengths of the model include the following aspects:

• The model is based on a theoretical framework that investigates major aspects of urban contexts with a relevant double indicator set.

• The model serves as an evaluation tool for assessing integrated performance of integrated approaches on urban contexts.

• The model plays as a design support tool for assisting the acceleration of processes toward low-carbon cities by setting a scenario-based analysis.

• The model can assist institutions and decision makers at the local level to monitor and evaluate urban processes by providing a snapshot of the current situation of districts and by providing a tool for improving planning quality.

The limitations of the model include some elements both internal of the research and external.

• First of all the availability and quality of data. In order to achieve a deep understanding of current district situation and for the accuracy of the model in itself, it is necessary to have access to qualitative data. This limitation is mainly due to unavailability of aggregated data, overall when data are covered by privacy regulations (e.g. data about buildings energy consumption). Also the GCC model had to make approximations and it had to omit some indicators. It is, in fact, recommended to examine some of them in future researches.

• Then, the cost of implementing both analysis through new models and pilot design practices. Therefore, the use of the model early in the design and development process in order to reduce costs and time can reduce partially this limitation. Piloting solutions will be necessary in the future for assessing the real functioning of the model.

• Many scientists argue a lack of competencies in cross-sectorial dimension for applying new multi-dimensional and multi-disciplinary approaches, as the one required by the GCC model. Furthermore, these competencies are needed also for involving stakeholders, which is a fundamental part of the model.

As a conclusion, this study has shown that the outcomes of the present research can be promising and worth further development first of all with the assessment into a pilot case and the validation among municipalities. Also the replication can be more investigated through the definition of interviews on the European level, both on municipalities and academia. In fact, further research can be carried out to adapt and apply the model in different districts and cities. In addition it is recommended to extend the analysis of current practises and approaches in order to create a transversal integration of the model with the existing practises.

The model resulting from this research detect the analysis of SC practises and a reflection about the role of extend smart boundaries to meet greener, sustainable and resilient approaches to the regeneration of the existing built environment at the district level. The key role of the model in decision-making process can be to provide information about current situation and to address the definition of a clear and log-term related perspective. Therefore, with the use of KPI applied to a scenario approach, the model helps practitioners to choose the most suitable strategy which best accomplish selected local targets. Moreover, the model can be further developed and tested into real case studies in order to facilitate implementation and to assess its functionality and quality. The model findings can promote coordination and collaboration between stakeholders, citizens, planners and architects towards ensuring the acceleration of a real transition toward green cities at the district level.

Figure 6 .1 SCCmodelintegrationwithregulatoryframework:integrationontheScopelevel.Personalanalysis

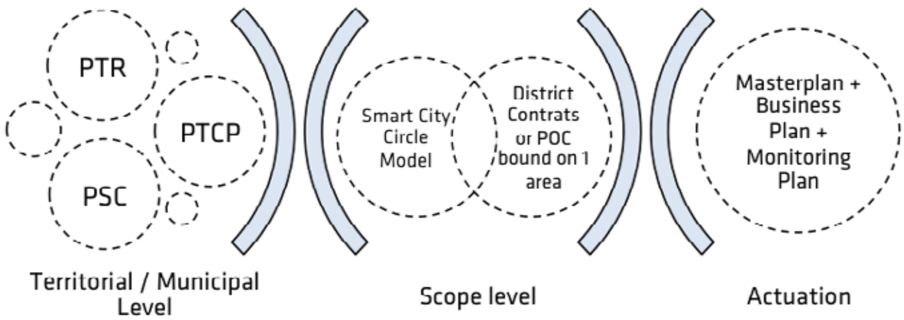
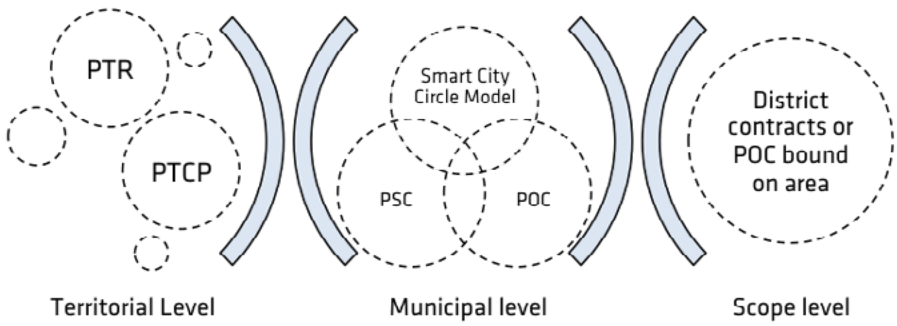


Figure 6 .2 SCCmodelintegrationwithregulatoryframework:integrationontheMunicipalLevel.Personalanalysis



BIBLIOGRAPHY

Bibliography is divided into a thematic analysis of major sources which contributed to the definition of the present research. For each thematic subdivision, the selection of 1 or 2 major sources are evidenced. These highlights are intended to evidence which are the main one or two sources that strongly addressed the research evolution.

Debate about smart, green, resilient cities, cities future and urban regeneration

• Agnello Domenico (2013), Università e Smart Cities, Nigeria, in "Rivista di Storia delle Idee 2:2", Università degli Studi di Palermo, Palermo, 2013, pp.27-31

• Antonini Ernesto et al. (2013), Edilizia sociale ad alta densità. Strumenti di analisi e strategie di rigenerazione: il quartiere Pilastro a Bologna, Milano, Bruno Mondadori Editore, 2013, pp. 209 (SAGGI DI ARCHITETTURA)

• Al-Hader Mahmoud, Rodzi Ahmad (2009), The Smart City infrastructure development & monitoring, in "Theoretical and Empirical Researches in Urban Management" n°2, 2009

• Angelidou Margarita (2014), Smart City policies: a spatial approach, in "Cities" n°41, 2014, pp.3-11, disponibile sul sito www.elsevier.com/locate/cities

• Annunziato Mauro (2012), La roadmap delle smart cities, all'interno di "Energia, Ambiente, Innovazione", Enea 2012, vol 4 p. 32-42

• Anthopoulos Leonidas G., Vakali Athena (2012), Urban Planning and Smart Cities: Interrelations and Reciprocities, in F. Alvarez et al. (Eds) FIA 2012, LNCS 7281, 2012, pp.178-189, disponibile sul sito SpringerLink.com

• Antonini Ernesto et al. (2015), Multi-layered urban strategies to foster the Smart Cities development. In Tenth International Conference on Urban Regeneration and Sustainability (Vol. 194, pp. 23–34). http://doi.org/10.2495/SC150031

• Balducci Alessandro, Fedeli Valeria (2007). Tracce di quartieri. In Territori della città in trasformazione. Tattiche e percorsi di ricerca. Milano: Angeli

• Barton Hugh (eds) (2000), Sustainable Communities. The Potential for Eco-Neighbourhoods. Statewide Agricultural Land Use Baseline 2015 (Earthscan). London, UK. http://doi.org/10.1017/CBO9781107415324.004

• Batty Michael et al. (2012), Smart Cities of the future, in "The European Physical Journal" n°214, 2012, pp.481-518, disponibile sul sito SpringerLink.com

• Batty Michael (2015), Creative Destruction, Long Waves and the Age of the Smart City. Retrieved from https://www.bartlett.ucl.ac.uk/casa/pdf/Working-Paper-200.pdf

• Batty Michael (2014), City 1.0, City 2.0, City n.0,..., City t, in "Environment and Planning" n°41, 2014, pp.1-2, disponibile sul sito www.elsevier.com

• Batty Michael (2013), The future city agenda, in "Environment and Planning" n°40, 2013, pp.191-194, disponibile sul sito www.elsevier.com

• Batty Michael (2013), Big data, smart cities and city planning. in Dialogues in Human Geography, 3(3), 274–279. http://doi.org/10.1177/2043820613513390

• Batty Michael (2008), Cities as Complex Systems: Scaling, Interactions, Networks, Dynamics and Urban Morphologies. UCL Working Paper Series (Vol. 131). Retrieved from http://www.springerlink.com/index/j3863x4mm7gu8645.pdf

• Berry Christopher R., Glaeser Edward L. (2005), The divergence of human capital levels across cities, NBER Working Paper Series 11617, http://www.nber.org/papers/w11617, Cambridge, 2005

• Bertello Agnese, Blanchetti Emilia (a cura di) (2013), City 2.0. Il futuro delle città. La sfida delle smart cities tra opportunità e necessità, progetto di L'Energia Spiegata in occasione del Festival dell'Energia, con un saggio di Marc Augé, 2013

• Bifulco Francesco et al. (2013), Multi-stakeholder innovation in Smart Cities management: some relevant experiences, in Electronic International Interdisciplinary Conference 2-6 settembre, 2013, disponibile sul sito http://www.eiic.cz/

• Bifulco Francesco et al. (2013), Cities and intelligent transport initiatives: a paradigmatic overview, in 1st International Virtual Conference on ITS, Section 1: Intelligent Transportation Systems, 2013

• Boccaccio Passoni Snc (2011 – a cura di), Lo sviluppo della Smart City. Un percorso di riflessione sui fattori di successo per la costruzione della città intelligente e sostenibile, Forum Green City Energy 26-27 Maggio, 2011, Pisa, disponibile sul sito www.greencityenergy.it

• Boeri Andrea, Gaspari Jacopo, (2015) A multi-layer approach to urban re generation: energy efficiency and comfort condition optimization, «TECHNE», 2015, 10, pp. 214 - 221

• Boeri Andrea, Antonini Ernesto, Gaspari Jacopo, Longo Danila (2015), Energy Design Strategies for Retrofitting. Methodology, Technologies and Applications, Southampton (UK), WIT press, 2015, pp. 216

• Boeri Andrea; Testoni Chiara (2015), Smart Cities: Public Policies and Business Models for a Sustainable Development. Stakeholder Networking and Innovative Public Procurement in Italy, «ARCHITECTONI.CA», 2015, 4, pp. 29 - 45

• Boeri Andrea; Testoni Chiara (2015), Smart Governance: urban regeneration and integration policies in Europe. Turin and Malmö case studies, in INTERNATIONAL JOURNAL OF SCIENTIFIC AND ENGINEERING RESEARCH», 2015, 6, pp. 527 - 533

• Boeri Andrea, Antonini Ernesto (2015), Strategie di trasformazione urbana. Il quartiere Pilastro e Bologna Smart City, in: RE-Cycling Social Housing. Ricerche per la rigenerazione sostenibile dell'edilizia residenziale sociale, Napoli, CLEAN, 2015, pp. 30 - 39 (capitolo di libro)

• Boeri Andrea et al. (2015), Transition to sustainable city: an integrated design approach for transformative districts - a proposal for replicability, in: The Sustainable City X, Southampton, UK, WIT Press, 2015, pp. 289 - 300 (capitolo di libro)

• Boeri Andrea et al. (2014), Innovative models and strategies for adapting the built environment to climate change, in: 40th IAHS World Congress on Housing|Sustainable Housing Construction, Porto, IAHS Ed., University of Porto, 2014, pp. 1 - 10 (atti di: 40th IAHS World Congress on Housing|Sustainable, Funchal, Madeira, 16-19 dicembre 2014)

• Boeri Andrea, Testoni Chiara (2014), Smart Governance: Strategic Planning and Urban Regeneration. Manchester and Turin Case Studies, «ARCHITECTONI.CA», 2014, 4, pp. 21 - 28

• Boeri Andrea, Boulanger Saveria O.M.; Gaspari Jacopo; Longo Danila (2014), Smart buildings and grids in the renovation of the built environment, in: World Sustainable Building 2014, Madrid, GBCe, 2014, 5, pp. 255 - 262 (atti di: World Sustainable Building 2014, Barcellona, 28-30 ottobre 2014)

• Boeri Andrea, Longo Danila (2012), From the Redevelopment of High-density Suburban Areas to Sustainable Cities, «ARCHITECTONI.CA», 2012, 2, pp. 118 - 130

• Boeri Andrea, Longo Danila (2012), High density suburbs redevelopment and social housing retrofitting for cities regeneration, in: The sustainable city VII : urban regeneration and sustainability. Volume I, SOUTHAMPTON, WIT Press, 2012, pp. 133 - 144 (WIT TRANSACTIONS ON ECOLOGY AND THE ENVIRONMENT) (capitolo di libro)

• Bonomi Aldo (2014), Piero della Francesca, pittore di Smart Land, in supplemento Domus 985 "The Smart City. La città dell'uomo", Novembre 2014, Milano, pp.23-25

• Bonomi Aldo e Masiero Roberto (2014), Dalla Smart City alla Smart Land, Marsilio editore, pp.144

• Campbell Tim (2012), Outlook for city learning: strategic note for United Cities and Local Governments and Metropolis, in "Urban Age", 2012

• Campbell Tim (2012), Beyond Smart Cities. How cities network, learn and innovate, Routledge ed., 2012

• Caragliu Andrea et al. (2009), Smart cities in Europe, in 3rd Central European Conference in Regional Science – CERS, 2009, 2012

• Carayannis Elias G. et al. (2012), The Quintuple Helix innovation model : global warming as a challenge and driver for innovation. in Journal of Innovation and Entrpreneurship, 1(2), 12. http://doi.org/10.1186/2192-5372-1-2

• Carayannis, Elias G. et al. (2009). "Mode 3"and'Quadruple Helix': toward a 21st century fractal innovation ecosystem. in International Journal of Technology Management, 46(3-4), 201–234.

• Carayannis, Elias G., & Campbell David F. J. (2012), Mode 3 Knowledge Production in Quadruple Helix Innovation Systems BT - Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: 21st-Century Democracy, Innovation, and Entrepreneurship for Development. In G. E. Carayannis & F. J. D. Campbell (Eds.) (pp. 1–63). New York, NY: Springer New York. http://doi.org/10.1007/978-1-4614-2062-0_1

• Chiapponi Medardo, TV 2020 Smart City Lab, in supplemento Domus 985 "The Smart City. La città dell'uomo", Novembre 2014, Milano, pp.20-22

• Claudel Matthew, Ratti Carlo (2016). Dimensions of the Future City. In Cities in the 21st century. Routledge. http://doi.org/10.1016/0169-2070(86)90041-5

• Cocchia Annalisa (2014), Smart and Digital City: A Systematic Literature Review, in R.P. Dameri and C.Rosenthal-Sabroux (eds.) "Smart City", Progress in IS, Springer International Publishing

Switzerland 2014

• Concilio Grazia et al. (2014), Exploring the interplay between urban governance and smart services codesign, in Interaction Design and Architecture(s) Journal - IxD&A, n 20, 2014, pp. 33-47

• Cosgrave Ellie et al. (2013), Living Labs, Innovation District and Information MArketplaces: A Systems Approach for Smart Cities, in “Procedia Computer Science” 16, 2013, pp. 668-677, Conf. on Systems Eng. Research, Atlanta, Elsevier

• Dal Sasso Daniele (2013), Edifici abbandonati, futuri data center?, in “Corriere Comunicazioni” n°19, 2013

• Dal Sasso Daniele (2013), ICT urbano a sostegno delle nuove famiglie, in “Corriere Comunicazioni” n°8, 2013

• Dal Sasso Daniele (2013), Creatività tecnologica leva di sviluppo urbano, in “Corriere Comunicazioni” n°9, 2013

• Dall’O Giuliano (2014), Smart City. La rivoluzione intelligente delle città. (Il Mulino, Ed.).

• Dameri Renata P., Benevolo Clara (2013), La smart city come strumento di green development. Il caso di Genova Smart City. in Impresa Progetto-Electronic Journal of …, 3, 1–36. Retrieved from http://www.impresaprogetto.it/contributions-and-working-papers/2013-3/benevolo-dameri

• Dameri, Renata P., Cocchia Annalisa (2013). Smart City and Digital City : Twenty Years of Terminology Evolution. In X Conference of the Italian Chapter of AIS, ITAIS 2013 (pp. 1–8).

• D’Antonio Simone (2013), Ai comuni serve un restyling <<Smart>>, in “Corriere Comunicazioni” n°14, 2013

• D’Antonio Simone (2013), Smart City, è tempo di <<proposer>>, in “Corriere Comunicazioni” n°18, 2013

• D’Antonio Simone (2013), Territori <<intelligenti>>. Il Sud va alla carica , in “Corriere Comunicazioni” n°16, 2013

• Deakin Mark (2013), Creating smart-er cities, Routledge, London, 2013

• Deakin Mark (2014), Smart cities: the state-of-the-art and governance challenge. in Triple Helix, 1, 7. http://doi.org/10.1186/s40604-014-0007-9

• Delrio Graziano (2013), L’italia dei comuni e la sfida della smart city. in Ecoscienza, 1, 64–65

• Di Battista Nicola (a cura di)(2014) –supplemento a Domus 985, The Smart City. La città dell’uomo, Novembre 2014, p. 90

• Dixon Tim, et al. (2013), Urban retrofitting: identifying disruptive and sustaining technologies using performance and foresight techniques, in “Technological Forecasting & social change”, 2013, disponibile sul sito http://dx.doi.org/10.1016/j.techfore.2013.08.027

• Eames Malcolm, Dixon Tim (2012), Visioning Retrofit Futures, in Retrofit 2050 – Working paper, 2012

• Fabian Lorenzo, Viganò Paola et al. (2012), Recycling city: lifecycles, embodied enegy, inclusion. Pordenone: Giavedoni editore.

• Faludi Andreas (2013), Territorial cohesion, territorialism, territoriality, and soft planning: a critical review, in “Environment and Planning” n°45, 2013, pp.1302-1317, disponibile sul sito www.elsevier.com

• Floater Graham, Rode Philipp (2014). Cities and the New Climate Economy: the transformative role of global urban growth. Retrieved from https://b7a2bff57ce0e87c1ddf-082e7e193ab68c7d-8c492b8b6f26a502.ssl.cf3.rackcdn.com/files/2014/12/The-Transformative-Role-of-Global-Urban-Growth-01.pdf

• Fusero Paolo, Massimiano Lorenzo (2012), Smart Cities, in Conferenza Nazionale SIU 10-12 maggio 2012, Pescara

• Giovannella Carlo (2013), “Territorial smartness” and emergent behaviours, in 2nd International Conference on Systems and Computer Science (ICSCS), 2013, IEEE, pp.170-176

• Graham Stephen (2000), Introduction : Cities and Infrastructure Networks. in International Journal of Urban and Regional Research, 24(1), 114–120. http://doi.org/10.1111/1468-2427.00238

• Hall Robert E. et al. (2000), The vision of a Smart City, in 2nd International Life Extension Technology Workshop, 28 settembre, Paris, 2000

• Hajer Maarten, Dassen Ton (2014), Visualizing the challenge for 21st century urbanism. (naio10 publisher / PBL publishers, Ed.). Amsterdam.

• Hall Peter (1996). Cities of tomorrow : an intellectual history of urban planning and design in the twentieth century ((1988;2002 ed.).

• Hall Peter (2013). Good Cities, Better Lives: How Europe Discovered the Lost Art of Urbanism (Routledge). London, UK.

• Hall Peter, Castells Manuel (1994). Technopoles of the World: The Making of 21st-Century Industrial Complexes. (Routledge, Ed.). London, UK.

• Hall Peter, Pfeiffer Ulrich (2000). Urban Future 21: a Global Agenda for Twenty-First Century Cities. (Routledge, Ed.). London, UK.

• Hall, R. E., at al. (2000). The vision of a smart city. in 2nd International Life Extension Technology Workshop (p. 7). Paris. Retrieved from ftp://24.139.223.85/Public/Tesis_2011/Paper_Correction_4-15-09/smartycitypaperpdf.pdf,

• Hollands, Robert (2008). Will the real smart city please stand up? in City, 12(3), 303–320. http://doi.org/10.1080/13604810802479126

• Kanter Rosabeth Moss, Litow Stanley S. (2009), A Manifesto for Smarter Cities, working paper of Harvard Business School, 2009 - ?

• Kitchin Rob (2014). The real-time city? Big data and smart urbanism. in GeoJournal, 79(1), 1–14. http://doi.org/10.1007/s10708-013-9516-8

• Komninos Nicos (2006). The architecture of intelligent cities: integrating human, collective and artificial intelligence to enhance knowledge and innovation. In 2nd IET International Conference on Intelligent Environments (IE 06) (Vol. 2006, pp. v1–13–v1–13). IEE. http://doi.org/10.1049/cp:20060620

• Komninos Nicos (2011). Intelligent cities: Variable geometries of spatial intelligence. in Intelligent Buildings International, 3(3), 172–188. http://doi.org/10.1080/17508975.2011.579339

• Komninos Nicos, Sefertzi Elena (1998). Neo-industrialisation and peripherality evidence from regions of Northern Greece. in Geoforum, 29(1), 37–49. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-0031824026&partnerID=tZOtx3y1

• Kourtit Karima, et al. (2013). An advanced triple helix network framework for smart city performance. In Routledge (Ed.), Deakin M (ed) Smart cities: governing, modelling and analysing the transition.. Oxon.

• Lefevre Pierre, Sabard Michel (2009). Les Écoquartiers, Éditions Apogée, Rennes, p. 320

• Leydesdorff Loet (2010). The Triple Helix , Quadruple Helix , …, and an N -tuple of Helices : Explanatory Models for Analyzing the Knowledge-based Economy ? in Available at: Www.leydersdorff.net/ntuple, 1–11. Retrieved from www.leydersdorff.net/ntuple

• Leydesdorff Loet, Deakin Mark (2010). The Triple Helix Model and the Meta-Stabilization of Urban Technologies in Smart Cities. in Journal of Urban Technology, 1–22.

• Ingersoll Richard, Ciberproletari di tutti i Paesi unitevi!, in supplemento Domus 985 "The Smart City. La città dell'uomo", Novembre 2014, Milano, pp.4-6

• Leigh Nancey Green, Hoelzel Nathanael (2012), Smart growth's blind side. Sustainable cities need productive urban industrial land, in "Journal of the American Planning Association" n°78, pp.87-103, disponibile sul sito http://dx.doi.org/10.1080/01944363.2011.645274

• Lindsay Greg (2010), The New New Urbanism, in "Fastcompany.com n°142, 2010, disponibile sul sito Fastcompany.com

• Manfredi Paolo (2013), Micro, piccole e medie imprese ultimo miglio della Smart City, in "Corriere Comunicazioni" n°12, 2013

• Marciano Claudio (2012), Il discorso sulla Smart City. Concetti chiave e sentieri di ricerca del nuovo spazio urbano, in Comunicazionepuntodoc, n°7, dicembre 2012-gennaio 2013

• Marsh Jesse (eds) (2014), The human Smart Cities Cookbook, in "Planum. The Journal of Urbanism" 28:1, 2014, special issue in collaboration wirh PERIPHERIA, www.planum.net

• Mele Renata, Oriol Nel.lo (eds) (2016). Cities in the 21st century, Routledge, 2016, p. 340

• Mitchell William J. (2000). E topia. London, UK, The MIT Press Cambridge.

• Monfaredzadeh, T., & Berardi, U. (2014). How can cities lead the way towards a sustainable, competitive and smart future? in WIT Transactions on Ecology and the Environment, (January), 1063–1074. http://doi.org/10.2495/SC140902

• Moretti Enrico (2014), La rinascita dei centri urbani, in supplemento Domus 985 "The Smart City. La città dell'uomo", Novembre 2014, Milano, pp.7-9

• Nam Taewoo, Pardo Theresa A. (2011), Conceptualizing Smart City with dimensions of technology, people and institutions, in "The Proceedings of the 21th annual international conference on digital governement research", College Park MD, USA, pp 282-291, 2011

• Neirotti Paolo, et al (2014), Current trends in Smart City initiatives: some stylised facts, in "Cities" 38, 2014, pp. 25-36, Elsevier, www.elsevier.com/locate/cities

• Neuman Michael (2005), The compact city fallacy, in "Journal Planning Education and Research" n°25, 2005

• Papa, R., et al (2016). Città metropolitane e Smart Governance. Iniziative di successo e nodi critici verso la Smart City (Tema Lab). Federico II Open Access University Press.

• Paroutis Sotirios, et al. (2013), A strategic view on smart city technology: the case of IBM Smarter Cities during a recession, in "Technological Forecasting & Social Change", 2013, disponibile sul sito http://dx.doi.org/10.1016/j.techfore.2013.08.041

• Partridge, Helen L. (2004). Developing a Human Perspective to the Digital Divide in the Smart City. In ALIA 2004 Biennial Conference Challenging Ideas (p. 7). Retrieved from http://conferences.alia.org.au/alia2004/conference.papers.html

• Partridge Helen L. (2005). Effecting social change in the " smart city ": the West End connect community project . Lynn McAllister Dr . Gillian Hallam Information Technology Services & Faculty of Information Technology Queensland University of Technology Paper presented to the Soci. In Social Change in the 21st Century Conference (pp. 1–16).

• Partridge Helen L., et al. (2007). Community ICT projects: do they really work? Reflections from the West End Connect project one year on. In L. Stillman, G. Johanson, & R. French (Eds.), Communities in Action.

• Pickett, S. T. A., et al. (2013). Ecological science and transformation to the sustainable city. in Cities, 32, S10–S20. http://doi.org/10.1016/j.cities.2013.02.008

• Pierce Neal, et al. (2013), Urban Futures. An atlantic perspective, The German Mashall Fund of the United States, in "Wider Atlantic Series", 2013, disponibile sul sito www.gmfus.org/publications

• Resch Bernd, et al. (2012). Live Urbanism, Towards SENSEable Cities and Beyond. In S. T. Rassia & P. M. Pardalos (Eds.), Sustainable Environmental Design in Architecture: Impacts on Health (pp. 175–184). New York, NY: Springer New York. http://doi.org/10.1007/978-1-4419-0745-5_10

• Rison Jeff (2014), Un'urbanistica per le persone, in supplemento Domus 985 "The Smart City. La città dell'uomo", Novembre 2014, Milano, pp.10-13

• Roche, Stéphane, et al. (2012), Are 'smart cities' smart enough. In: Global geospatial conference. 2012. p. 215-235.

• Santis, R. De, et al.. (2012). Smart City: Fact and Fiction. in Innovation: The European Journal of Social Science Research, 25(54536), 137–149. http://doi.org/10.1080/13511610.2012.660325

• Secchi Bernardo (2002). 06- Scenarios. in Planum. The Journal of Urbanism, 2(5).

• Secchi Bernardo (2003a). 10- Projects, visions, scenarios. In Diary of a planner. in Planum. The Journal of Urbanism, 7(2). Retrieved from http://www.planum.net/projects-visions-scenarios

• Secchi Bernardo (2003b). 11- The form of the city. in Planum. The Journal of Urbanism, 7(2).

• Secchi Bernardo (2013). La città dei ricchi e la città dei poveri. (Laterza, Ed.).

• Secchi Bernardo, Viganò Paola (2012). La ville poreuse. Geneve: Metis Press.

• Shelton, T., et al. (2015). The "actually existing smart city." in Cambridge Journal of Regions, Economy and Society, 8(October 2014), 13–25. http://doi.org/10.1093/cjres/rsu026

• Smith, B. L. (2001). The third industrial revolution: policymaking for the Internet. in Colum. Sci. & Tech. L. Rev., 3, 1.

• Steffen, W., Crutzen, P. J., & McNeill, J. R. (2007). The Anthropocene: are humans now overhelming the Great Force of Nature? in AMBIO: A Journal of the Human Environment, 36:8 Scien(December 2007).

• Sullivan Lewis, et al. (2014), Neighbourhood Sustainability Frameworks – A Literature Review. Framework for assessing the sustainability of the built environment with a focus at the neighbourhood level, UCL Centre for Urban Sustainability and Resilience (USAR), www.ucl.ac.uk/usar/WPS

• Testa Paolo (2014), La dimensione umana della Smart City, in supplemento Domus 985 "The Smart City. La città dell'uomo", Novembre 2014, Milano, pp.14-15

• Tranchard Sandrine (2012), Building smart cities. How ISO standards contributes, in ISO Focus+, 4/1, 2013

• Vallianatos, M. (2015). Uncovering the Early History of "Big Data" and the "Smart City" in Los Angeles. in BOOM: A Journal of California.

• Verhoef Erik, Nijkamp Peter (2008), Urban environmental externalities, agglomeration forces and the technological "Deus ex machina", in "Environment and Planning" n°40, 2008, pp. 928-947

• Viganò, P., & Fabian, L. (2010). The extreme city: climate change and the transformation of the waterscape. in TERRITORIO, 53, 91–100. http://doi.org/10.3280/TR2010-053015

• Vitali Walter (2014), Un'agenda per le città. Nuove visioni per lo sviluppo urbano, Ed. Il Mulino, Bologna, 2014, p 256
• Vollaro De Lieto Roberto, Evangelisti Luca, Carnielo Emiiano et al (2014), An Integrated Approach for an Historical Buildings Energy Analysis in a Smart Cities perspective, in "Energy Procedia" 45, 2014, pp. 372-378, 68th Conf. of the Italian Thermal Machines Eng. Ass. Elsevier
• Washburn Doug, Sindhu Usman (2010), Helping CIOs Understand "Smart City" Initiatives, Forrester Research, 2010
• Wolfram Marc (2012), Decostructing Smart Cities: an intertextual reading of concepts and practises for integrated urban and ICT development, in Real Corps 14-16 Maggio, 2012, pp.171-180
• Zamboni Andrea (2014), La città è intelligente, l'uomo è rinsavito?, in supplemento Domus 985 "The Smart City. La città dell'uomo", Novembre 2014, Milano, pp.2-3

Climate change and climate trends analysis related bibliography

• Arnell, N. W. (1999). The effect of climate change on hydrological regimes in Europe: A continental perspective. in Global Environmental Change, 9(1), 5–23. http://doi.org/10.1016/S0959-3780(98)00015-6
• Coutard, Olivier, et al. (2014) Urban Megatrends: Towards a European Research Agenda. 2014.
• Crutzen, P. J. (2006). The Anthropocene, in Earth System Science in the Anthropocene. Ehlers: Eckart, Krafft, Thomas (Eds.).
• Cutter, Susan L.; Burton, Christopher G.; and Emrich, Christopher T. (2010) "Disaster Resilience Indicators for Benchmarking Baseline Conditions," Journal of Homeland Security and Emergency Management: Vol. 7: Iss. 1, Article 51. DOI: 10.2202/1547-7355.1732
• EPA. (2011). Climate Change & Air Quality (Vol. 2).
• IPCC. (2013). Climate Change: action, trends and implications for business. The IPCC's Fifth Assessment Report.
• IPPC. (2014). Climate Change 2014: Synthesis Report.
• Richardson, K. (2012). Climate change: Global risks, challenges and decisions. Eos, Transactions American Geophysical Union (Vol. 93). http://doi.org/10.1029/2012EO180011
• Scripps Institute of Oceanography. (2016). Mauna Loa Observatory analysis. Retrieved from http://scrippsco2.ucsd.edu/graphics_gallery/mauna_loa_record
• Van der Hoeven, M. (2011). CO2 Emissions from Fuel Combustion. International Energy Agency. Retrieved from http://www.oecd-ilibrary.org/energy/co2-emissions-from-fuel-combustion-2011_co2_fuel-2011-en

Microclimate analysis, indoor and outdoor comfort, energy efficiency on built environment

• Adunola Adewale Oluseyi (2014), Evaluation of urban residential thermal comfort in relation to indoor and outdoor air temperatures in Ibadan, Nigeria, in "Building and environment" n°75, 2014, pp.190-205, disponibile sul sito www.elsevier.com/locate/buildenv
• Allegrini J., Kamof J., Dorer V. Carmeliet J. (2013), Modelling the urban microclimate and its influence on building energy demands of an urban neighbourhood, in CISBAT 2013, Lausanne
• Arnold, C. L., & Gibbons, C. J. (1996). Impervious Surface Coverage: The Emergence of a Key Envi-

ronmental Indicator. in Journal of the American Planning Association, 62(2), 243–258. http://doi.org/10.1080/01944369608975688

• Bouyer Julien, Musy Marjorie, Huang Yuan et al (2009), Mitigating Urban Heat Island effect by urban design: forms and materials, in Fifth Urban Research Symposium, 2009

• Chen, K., Jiao, Y., & Lee, E. S. (2006). Fuzzy adaptive networks in thermal comfort. in Applied Mathematics Letters, 19(5), 420–426. http://doi.org/10.1016/j.aml.2005.06.013

• Dorer Viktor, Allegrini Jonas, et al (2013), Modelling the urban microclimate and its impact on the energy demand of buildings and building clusters, in Proceedings of BS2013. 13th Conf. of Intern. Building Performance Simulation Association, France, 2013

• Dounis, A. I., & Caraiscos, C. (2009). Advanced control systems engineering for energy and comfort management in a building environment-A review. in Renewable and Sustainable Energy Reviews, 13(6-7), 1246–1261. http://doi.org/10.1016/j.rser.2008.09.015

• Erell Evyatar, Pearlmutter David, Williamson Terry, (2011), Urban Microclimate. Designing the Spaces between Buildings, Earthscan, London, 2011

• Estoque Ronald C, Murayama Yuji (2014), Social-ecological status index :a preliminary study of its structural composition and application, in "Ecological Indicator" n°43, 2014, pp.183-194, disponibile sul sito www.elsevier.com/locate/ecolind

• Fanger, P. (1972). Thermal comfort: analysis and applications in environmental engineering. (McGraw-Hil). New York, New York, USA.

• Ferrante Annarita (2014), Energy retrofit to nearly zero and socio-oriented urban environments in the Mediterranean climate, in "Sustainable Cities and Society" 13, 2014, pp. 237-253, Elsevier, www.elsevier.com/locate/scs

• Georgi N.J., Zafiriadis K. (2006), The impact of park trees on microclimate in urban areas, in Urban Ecosyst 9, 2006, pp.195-209, Springer Science + Business Media, DOI 10.1007/s11252-006-8590-9

• Gorsevski Virginia, et al. (1998) Air pollution prevention through urban heat island mitigation: An update on the Urban Heat Island Pilot Project. Proceedings of the ACEEE Summer Study, Asilomar, CA, 1998, 9: 23-32.

• Guhathakurta Subhrajit, Gober Patricia (2007), The Impact of the Phoenix Urban Heat Island on Residential Water Use, in Journal of the American Planning Association, 73:3, 2007

• Guite, H. F., et al. (2006). The impact of the physical and urban environment on mental well-being. in Public Health, 120(12), 1117–1126. http://doi.org/10.1016/j.puhe.2006.10.005

• Jebson, S. Fact sheet number 14: Microclimates. 2007.

• Legambiente (2014 – a cura di), Tutti in classe A. Radiografia energetica del patrimonio edilizio italiano, 2014

• Matzarakis, A., et al (2007). Thermal bioclimate analysis for Europe and Italy. in Nuovo Cimento Della Societa Italiana Di Fisica C, 30(6), 623–632. http://doi.org/10.1393/ncc/i2007-10268-0

• Nunez, M., Oke, T. R. (1977). The Energy Balance of an Urban Canyon. in Journal of Applied Meteorology. http://doi.org/10.1175/1520-0450(1977)016<0011:TEBOAU>2.0.CO;2

• O'Campo, P., Salmon, C., & Burke, J. (2009). Neighbourhoods and mental well-being: What are the pathways? in Health and Place, 15(1), 56–68. http://doi.org/10.1016/j.healthplace.2008.02.004

• Observatoire National sur les Effets du Réchauffement climatique, (2010), Villes et Adaptation au changement climatique, Rapport au Premier Ministre et au Parlement, 2010

• Pallett Helen, Chilvers Jason (2013), A decade of learning about publics, participation, and climate change: institutionalising reflexivity?, in "Environment and Planning" n°45, 2013, pp.1162-1183, disponibile sul sito www.elsevier.com

• Papa R., et al. (2013), Towards an Urban Planners' Perspective in Smart Cities, in "Tema" vol 6 n°1, 2013, Università Federico II di Napoli, pp.6-17

• Petrova Saska, Gentile Michael, Makinen Ilkka Henrik, Bouzarovski Stefan (2013), Perceptions of thermal comfort and housing quality: exploring the microgeographies of energy poverty in Stakhanov, Ukraine, in "Environment and Planning" n°45, 2013, pp.1240-1257, disponibile sul sito www.elsevier.com

• Rode Philipp, et al. (2014), City and energy: urban morphology and residential heat-energy demand, in "Environment and Planning" n°41, 2014, pp. 138-162, disponibile sul sito www.elsevier.org

• Santamouris Matheos (2013), Using cool pavements as a mitigation stratefy to fight urban heat island- a review of the actual development, in "Renewable and Sustainable energy reviews" n°26, 2013, pp.224-240, disponibile sul sito www.elsevier.com/locate/rser

• Santamouris Matheos (2007). Heat island research in Europe. The state of the art. in Adv. Build. Energy Res., 1, 123–150.

• Santamouris Matheos (2016). Innovating to zero the building sector in Europe: Minimising the energy consumption, eradication of the energy poverty and mitigating the local climate change. in Solar Energy, 128, 61–94. http://doi.org/10.1016/j.solener.2016.01.021

• Santamouris Matheos, et al. (2001). On the impact of urban climate to the energy consumption of buildings. in Solar Energy, 70(3), 201–216.

• Schmidt R.R., et al. (2012), Smart thermal networks for smart cities – Introduction of concepts and measures, in EPJ Web Conference, 2012, disponibile sul sito http://dx.doi.org/10.1051/epjconf/20123304002

• Setaih Khalid, Hamza Neveen, Townshend Tim (2013), Assessment of outdoor thermal comfort in urban microclimate in hot arid ares, in Proceedings of BS2013. 13th Conf. of Intern. Building Performance Simulation Association, France, 2013

• Shashua-Bar Limor, et al. (2012), Passive cooling design options to ameliorate thermal comfort in urban streets of a MEditerranean climate (Athens) under hot summer conditions, in "Building and Environment" 57, 2012, pp. 110-119, Elsevier, www.elsevier.com/locate/buildenv

• Shishegar Nastaran (2013), Street Design and Urban Microclimate: Analyzing the Effects of Street Geometry and Orientation on Airflow and Solar Access in Urban Canyons, in Journal of Clean Energy Technologis, 1:1, 2013

• Steeneveld G.J., et al (2011), Quantifying urban heat island effects and human comfort for cities of variable size and urban morphology in the Netherlands, in Journal of Geophysical Research 116, D20129, doi:10.1029/201 1JD015988

• Taha Haider (1997), Urban climates and heat islands: albedo, evapotranspiration, and anthropogenic heat, in Energy and Building 25, 1997, pp. 99-103

• Tumini Irina, Garcia Ester Higueras (2010), Design strategies to reduce the Heat-Island in the urban space. Madrid Stadium Case, in 4th Congress The Challenges of Planning in a Web Wide World, 6-8 Ottobre, 2010

• Vardoulakis, S., et al. (2003). Modelling air quality in street canyons: A review. in Atmospheric

Environment, 37(2), 155–182. http://doi.org/10.1016/S1352-2310(02)00857-9

• Veerbeek William, et al. (2011) Urban growth modeling to predict the changes in the urban microclimate and urban water cycle. IWA-International Water Association, 2011.

• Wing Robert D. (2008) Smart energy houses of the future–self-supporting in energy and zero emission. Future Energy: Improved, Sustainable and Clean Options for our Planet, 2008, 333.

• Wong Nyuk Hien, et al. (2011), Integrated urban microclimate assessment method as a sustainable urban development and urban design tool, in Landscape and Urban Planning 100, 2011, pp. 386-389, Elsevier, www.elsevier.com/locate/landurbplan

• Yang Jiachuan, et al. (2014), Unintended Consequences. A Research Synthesis Examining the Use of Reflective Pavements to Mitigate the Urban HEat Island Effect, Nationa Center of Excellence for Smart Innovations, Arizona State University, 2014

Literature about indicators and scenario

• Courtney, Hugh (2003). Decision-driven scenarios for assessing four levels of uncertainty. Strategy & Leadership, 2003, 31.1: 14-22.

• Gabrielsen, P., & Boch, P. (2003). Environmental Indicators: Typology and Use in Reporting. Copenhagen.

• Giffinger, R. (2015). Smart City Indicators meanings of indicator in a place base understanding. In EERA JP Smart Cities. Retrieved from http://www.treccani.it/vocabolario/smart-city_(Neologismi)/

• Hammond, Allen; WORLD RESOURCES INSTITUTE. (1995) Environmental indicators: a systematic approach to measuring and reporting on environmental policy performance in the context of sustainable development. Washington, DC: World Resources Institute, 1995.

• Harder, M. K., et al. (2014). Reconceptualizing "effectiveness" in environmental projects: Can we measure values-related achievements? in Journal of Environmental Management, 139, 120–134. http://doi.org/10.1016/j.jenvman.2014.02.022

• Leutbecher, M., & Palmer, T. N. (2008). Ensemble forecasting. Journal of Computational Physics, 227(7), 3515-3539.

• Lombardi, P., et al (2012). Modelling the smart city performance. in Innovation: The European Journal of Social Science Research, 25(February 2015), 137–149. http://doi.org/10.1080/13511610.2012.660325

• Martin, C. V. (2013). Indicators for smart cities. Oberview and proposals with emphasis in Energy, Carbon and Mobility issues.

• Meadows, D. (1998). Indicators and Information Systems for Sustainable, 78.

• Nardo, M., et al. (2005). A Tools for Composite Indicators Building. Joint Research Centre European Commission. Institute for the Protection and Security of the Citizen Econometrics and Statistical Support to Antifraud Unit, Ispra, 2005.

• OECD. (2001). OECD Environmental Indicators toward sustainable development.

• OECD. (2008). Handbook on Constructing Composite Indicators: Methodoloy and User Guide.

• Ogilvy, J. A., Scwartz, P. (2002). Creating Better Futures: Scenario Planning as a Tool for a Better Tomorrow. (Oxford, Ed.). Retrieved from http://www.amazon.it/Creating-Better-Futures-Scenario-Creativity-ebook/dp/B007K5XGEA/ref=sr_1_1?ie=UTF8&qid=1458730445&sr=8-1&keywords=creating+better+futures

•

Models, ranking and rating instruments related bibliography

• Berst, J., et al. (2013). Smart Cities Readiness Guide, 281. Retrieved from http://smartcitiescouncil.com/resources/smart-cities-readiness-guide

• Between Spa (a cura di) (2013), Smart City index. Confrontarsi per diventare Smart, report 2013 (prima edizione)

• Between Spa (a cura di) (2014), Smart City index. Confrontarsi per diventare Smart, report 2014 (seconda edizione)

• BREEAM. (2012). BREEAM Communities. Technical Manual. Retrieved from http://www.breeam.org/

• Charoenkit, S., & Kumar, S. (2014). Environmental sustainability assessment tools for low carbon and climate resilient low income housing settlements. in Renewable and Sustainable Energy Reviews, 38, 509–525. http://doi.org/10.1016/j.rser.2014.06.012

• Chastenet, C. A., et al. (2016). The French eco-neighbourhood evaluation model: Contributions to sustainable city making and to the evolution of urban practices. in Journal of Environmental Management, 176, 69–78. http://doi.org/10.1016/j.jenvman.2016.03.036

• CASBEE. (2015). CASBEE for Cities. Pilot version for worldwise use, available at http://www.ibec.or.jp/CASBEE/english/overviewE.htm

• Covenant of Mayors (2013 – a cura di), Covenant of Mayor Charte, 2013, disponibile sul sito www.eumayors.eu

• Defense Council and the US Green Building Council (2013), LEED 2009 for Neighbourhood development, Congress for the New Urbanism, Natural Recources, October 2013

• Forum PA (2012 – a cura di), I-City Rate. La classifica delle città intelligenti italiane, 2012, prima edizione

• Forum PA (2013 – a cura di), I-City Rate. La classifica delle città intelligenti italiane, 2013, seconda

• Forum PA (2014 – a cura di), I-City Rate. La classifica delle città intelligenti italiane, 2014, terza edizione edizione

• Forum PA (a cura di). (2015). ICity Rate. La classifica delle città intelligenti italiane.

• Gang He et al. (2013), ELITE Cities: A low-carbon eco-city evaluation tool for China, ECEEE SUMMER STUDY proceedings

• GBC. (2015). GBC QUARTIERI - Edizione 2015, available at http://www.gbcitalia.org/page/show/gbc-quartieri?locale=it

• Giffinger, Rudolf, et al. (2007). City-ranking of European medium-sized cities. Cent. Reg. Sci. Vienna UT, 2007.

• Giffinger, Rudolf, et al. (2014). PLEEC. Planning for energy efficient cities. Methodology for monitoring.

• Giffinger, R., Strohmayer, F. (2014). PLEEC. Planning for energy efficient cities (project EU). Typology of cities.

• GIZ, & ICLEI. (2014). Operationalizing the Urban NEXUS. Towards resource-efficient and integrated cities and metropolitan regions.

• Green Growth Knowledge Platform. (2013). Moving towards a Common Approach on Green

Growth Indicators.
• LEED for Neighbourhood (2013), GBC Quartieri, Edizione 2013
• LEED for Neighbourhood (2015), GBC Quartieri, Edizione 2015
• Meijering Jurrian V., et al. (2013), Identifying the methodological characteristics of European Green City Rankings, in "Ecological Indicator" n°43, 2013, pp.132-142, disponibile sul sito www.elsevier.com/locate/ecolind
• Siemens. (2012). The Green City Index, available at: https://www.siemens.com/entry/cc/features/greencityindex_international/all/en/pdf/gci_report_summary.pdf
• Testa Paolo (2013 – a cura di), Vademecum per le città intelligenti, 2014, Edizioni Forum PA, 2013, disponibile sul sito www.osservatoriosmartcity.it, www.cittalia.it, www.anci.it
• Vienna University of Technology, University of Ljubljana, Delft University of Technology (a cura di) (2007), Smart Cities. Ranking of European medium-sized cities, 2007

<u>**Data, digital technology and ICT related bibliography**</u>

• Bishop Ian D., Pettit Christopher J., Sheth Falak, Sharma Subhash (2013), Evaluation of data visualisation options for land-use policy and decision making in response to climate change, in "Environment and Planning" n°40, 2013, pp.213-233, disponibile sul sito www.elsevier.com
• Buongiovanni Chiara (2013), Comunità intelligenti da misurare. Arriva la statistica Smart, per Forum PA, 2013, disponibile sul sito http://saperi.forumpa.it/story/69961/comunita-intelligenti-da-misurare-arriva-la-statistica-smart
• Dascalu Mihai, Scaccia Federico, Giovannella Carlo (2014), Smart City Analytics: state of the art and future perspectives. IxD&A, 2014, 20: 72-87.
• Dizdaroglu Didem, Yigitcanlar Tan (2014), A parcel-scale assessment tool to measure sustainability through urban ecosystem components: the musix model, in "Ecological Indicator" n°41, 2014, pp.115-130, disponibile sul sito www.elsevier.com/locate/ecolind
• Ferro Enrico, et al. (2013), The role of ICT in smart cities governance. In: Conference for E-Democracy and Open Governement. 2013. p. 133.
• Florea Anna et al. (2013), Decision support tool for retrofitting a district towards district as a service, in Urb-Grade project FP7-EU, 2013
• Khorov Evgeny, et al. (2015) A survey on IEEE 802.11 ah: An enabling networking technology for smart cities. Computer Communications, 2015, 58: 53-69.
• Kramer Anna, et al. (2014), Smart Sustainable cities- Exploring ICT solutions for reduces energy use in cities, in "Environmental Modelling & Software" n°56, 2014, pp.52-62, disponibile sul sito www.elsevier.com/locate/envsoft
• Krishna Venkata, Matturi Kumar (2013), Smart Urbanization. Emerging paradigms of sensing and managing urban system, in "Planum. The Journal of Urbanism" vol 2 n°27, 2013
• Lee Jungwoo, Lee Hyejung (2014), Developing and validating a citizen-centric typology for Smart City services, in "Government Information Quaterky " n°31, 2014, pp.93-105, disponibile sul sito www.elsevier.com/locate/govinf
• Lee Jung Hoon, Phaal Robert, Lee Sang Ho (2013), An integrated service-device-technology roadmap for Smart City development, in "Technological Forecasting & Social Change" n°80, 2013, pp.286-306, disponibile sul sito www.elsevier.com
• Volpi Valentina et al. The ItalianNeedMap: a Participatory Open Citizens-Oriented Tool for a

Qualitative Development Planning Process in Smart Territories, available at http://www.mifav.uniroma2.it/inevent/events/pcst_sce_2013/docs/II_4.pdf

• Lombardi Patrizia, et al. (2012), Modelling the smart city performance, in "Innovation: The European Journal of Social Science Research", 25:2, pp.137-149, http://dx.doi.org/10.1080/13511610.2012.660325

• Lombardi Patrizia (2011), New challenges in the evaluation of Smart Cities, in "Network Industries Quaterly" 13:3, 2011

• Khansari Nasrin, Mostashari Ali, Mansouri Mo (2014), Conceptual Modeling of the Impact of Smart Cities on Household Energy Consumption, in Procedia Computer Science 28, Conference on Systems Engineering Research, California, 2014, Elsevier, pp.81-86

• Yigitcanlar Tan, Dur Fatih, Dizdaroglu Didem (2014), Towards propserous sustainable cities: A multiscalar urban sustainability assessment approach, in Habitat International ?, , 2014, Elsevier, www.elsevier.com/locate/habitatint

• Lazaroiu George Cristian, Roscia Mariacristina (2012), Definition methodology for the smart cities model, in "Energy" 47, 2012, pp. 326-332, Elsevier, www.elsevier.com/locate/energy

Financing and economy related bibliography

• Cassa Depositi e Prestiti Spa (a cura di) (2013), Smart city. Progetti di sviluppo e strumenti di finanziamento, 2013

• Daly, Herman (2014). The steady State Economic. From toward a Steady State Economy (1973), in The sustainable Urban Development Reader, 3rd edition, edited by Stephen M. Wheeler,Timothy Beatley, Routdledge, 2014, available at: https://books.google.it/books?hl=it&lr=&id=OmWvBAAAQBAJ&oi=fnd&pg=PA55&dq=daly+steady+state+economy&ots=vmmA1554yS&sig=9MkayJ-Kc7riLqbpKaR8wkIgp1w#v=onepage&q=daly%20steady%20state%20economy&f=false

• Smart Cities Stakeholder Platform – Finance working group (2013 – a cura di), Using EU funding mechanism for smart cities, 2013

• European Commission – Directorate General for Enterprise and Industry (2012), The Smart Guide To Service Innovation. How to support SME Policy from Structural Funds, Guidebook Series 4, 2012, http://ec.europa.eu/enterprise/policies/innovation/support/

Literature about policies (European and national), statistics and EU agencies reports

• ADEME. (2015). Energy efficiency trends and policies in the household and tertiary sectors. An analysis based on the ODYSSEE and MURE databases.

• Agenzia per l'Italia digitale (eds) (2012), Architettura per le Comunità Intelligenti. Visione concettuale e raccomandazioni alla pubblica amministrazione, versione 2.0 del 3/10/2012

• BMUB. (2014). GreenTech made in Germany 4.0 – Environmental Technology Atlas for Germany. Retrieved from http://www.greentech-made-in-germany.de/fileadmin/user_upload/greentech_atlas_4_0_en_bf.pdf

• Borghi Antonio (2013 – a cura di), Building energy efficiency in European Cities, URBACT, 2013, disponibile sul sito http://urbact.eu

• Directorate-General for internal policies- European Parliament. (2014). Mapping Smart Cities in the EU. Retrieved from http://www.europarl.europa.eu/RegData/etudes/etudes/join/2014/507480/IPOL-ITRE_ET(2014)507480_EN.pdf

• Econometrics, C., & Garden, C. (2013). Employment Effects of selected scenarios from the Energy roadmap Final report for the European Commission.

• EEA. (2005). EEA core set of indicators, Technical Report, 1/2005.

• Energy Cities (2014 – a cura di), Local leaders making the difference, n°42, 2014, disponibile sul sito www.energy-cities.eu

• Engelke Peter (2013), Foreign policy for an urban world: global governance and the rise of cities, Atlantic Council – Brent Scowcroft center on Internationale Security, 2013

• European Commission (2010), SET-PLAN towards a low-carbon future, 2010

• European Commission (2014), Horizon 2020 Calls, 2014

• European Innovation Partnership on SmartCities and Communities (2013 – a cura di), Strategic Implementation Plan, 2013

• Espon. (2012). Regions and cities in the global economy.

• Espon. (2013). Natural Hazards and Climate Change in European Regions.

• Espon. (2014). Making Europe Open and Polycentric.

• Europea, C. (2007). European smart cities. in Conferenza Stampa.

• European Commission Directorate General. (2015). LIFE and Climate change adaptation.

• European Commission, & Science for Environment Policy. (2015). Indicators for sustainable cities. Retrieved from http://ec.europa.eu/environment/integration/research/newsalert/pdf/indicators_for_sustainable_cities_IR12_en.pdf

• European Environment Agency. (1999). Environmental indicators : Typology and overview (Vol. 25). Retrieved from http://www.eea.europa.eu/publications/TEC25

• European Environment Agency. (2012). Urban adaptation to climate change in Europe. Challenges and opportunities for cities together with supportive national and European policies.

• European Environment Agency (EEA). (2014). Digest of EEA indicators 2014. http://doi.org/10.2800/17963

• European Parliament, & Council of the European Union. (2008). Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe. in Official Journal of the European Communities, 1–43. http://doi.org/http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:152:0001:0044:EN:PDF

• European Union, R. P. (2011). Cities of tomorrow. Challenges, visions, ways forward.

• ISO/IEC JTC 1. (2014). Smart Cities. Preliminary Report 2014. Switzerland. Retrieved from http://www.iso.org/iso/smart_cities_report-jtc1.pdf

• Lewis J. Owen, Hogain Sadhbh Ni, Borghi Antonio, (2013), Energy Efficiency in European Cities. Cities of Tomorrow-Action Today, URBACT II Capitalisation, 2013

• Mandl, C., & Kuttner, T. (2014). European Smart City Initiative.

• Manitiu, D. N., & Pedrini, G. (2015). Smart and sustainable cities in the European Union. An ex ante assessment of environmental , social , and cultural domains.

• OECD. (2012). Cities in Europe. The new OECD-EC Definition. Regional Focus. Retrieved from http://ec.europa.eu/regional_policy/sources/docgener/focus/2012_01_city.pdf

• OTB Research Institute for the Built Environment. (2010). Housing Statistics in the European Union. Delft, University of Technology.

• Parlamento Europeo. (2010). Direttiva 2010/31/UE sulla prestazione energetica nell'e.

• Parlamento Europeo. (2012). Direttiva 2012/27/EU sull'efficienza energetica. Retrieved from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:315:0001:0056:IT:PDF

• Smart City Council (2013 – a cura di), Smart City readiness guide. The planning manual for building tomorrow's cities today, 2013

• Smart Cities Stakeholder Platform – Roadmap Group (2013 – a cura di), Key message for the high-level group, 2013

• Smart Cities Stakeholder Platform – Finance working group (2013 – a cura di), Guidance document. Integrated Action-plan – report process & guidelines for smart cities, 2013

• Smart Cities Stakeholder Platform – Roadmap Group (2013 – a cura di), 10 years rolling agenda, 2013,

• Smart Cities Stakeholder Platform (2013 – a cura di), Key to innovation integrated solution. Integrated urban energy governance, 2013

• Smart Cities Stakeholder Platform (2013 – a cura di), Virtual energy plan, 2013

• Smart Cities Stakeholder Platform (2013 – a cura di), Key message for the high-level group, 2013

• Smart Cities Stakeholder Platform (2013 – a cura di), Integrated urban energy governance, 2013

• Smart Cities Stakeholder Platform (2013 – a cura di), ICT stack for energy management, 2013

• Smart Cities Stakeholder Platform (2013 – a cura di), Heat pump and micro-CHP as complementary boiler alternativers, 2013

• Smart Cities Stakeholder Platform (2013 – a cura di), Key innovation and strategies, 2013

• Smart Cities Stakeholder Platform (2013 – a cura di), Advanced materials for energy efficient buildings, 2013

• UNEP SBCI. (2009). Buildings and climate change: a summary for decision-makers. United Nations Environmental Programme, Sustainable Buildings and Climate Initiative. Retrieved from http://www.unep.org/sbci/pdfs/sbci-bccsummary.pdf

• UNFPA. (2008). International Migration and Human Rights.

• UNFPA. (2013). International Migration and Development : Contributions and Recommendations of the International System. United Nations System.

• UNFPA. (2014a). The power or 1.8 billion. Adolescent, youth and the transformation of the future. State of the World Population 2014. Retrieved from http://www.unfpa.org/sites/default/files/pub-pdf/EN-SWOP14-Report_FINAL-web.pdf

• UNFPA. (2014b). World Urbanization Prospects.

• UNFPA and HelpAge. (2012). Ageing in the Twenty-First Century:A Celebration and AChallenge. United Nations Population Fund. Retrieved from http://link.springer.com/chapter/10.1007/978-3-662-04375-2_2

• United Nations. (2007). Indicators of Sustainable Development : Guidelines and Methodologies. New York. http://doi.org/10.1016/j.cirpj.2010.03.002

• United Nations. (2014). World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352). New York, United. Retrieved from http://esa.un.org/unpd/wup/Highlights/WUP2014-Highlights.pdf

• United Nations. (2015). Transforming our world. The 2030 agenda for sustainable development.

• World Business Council for Sustainable Development. (2010). Vision 2050. The new agenda for business.

Case studies related bibliography

- Agenzia per l'Italia digitale (eds) (2012), Architettura per le Comunità Intelligenti. Visione concettuale e raccomandazioni alla pubblica amministrazione, versione 2.0 del 3/10/2012
- AGMA (2010), Greater Manchester's Low Carbon Economic Area for the Built Environment Joint Delivery Plan, Association of Greater Manchester Authorities, 2010
- City of Copenhagen (eds). (2012). Climate Plan 2025. A green, smart and carbon neutral city.
- City of Copenhagen (eds). (2011). Copenhagen Climate Adaptation Plan.
- City of Copenhagen (eds). (2014a). Copenhagen climate resilient neighbourhood.
- City of Copenhagen (eds). (2014b). Copenhagen: solutions for Sustainable Lifestyles. Retrieved from www.cphcleantech.com
- City of New Tork (a cura di) (2012), New York City's digital roadmap. Progress & Innovation, 2012, New York
- Commissariat Général du developpement durable (2009 – a cura di), Horizon 2030-2050. Veille de la mission prospective, 2009, disponibile sul sito www.developpement-durable.gouv.fr
- Copenhagen Cleantech Cluster. (2013). Danish Smart Cities: Sustainable living in an urban world. An overview of Danish Smart City competencies.
- Culgin, K., et al. (2013). Benefit-Cost Analysis of BigBelly Solar Trash Compactors in City of Seattle Parks. in The Evans School Review, 3(1), 51–61.
- Danish Energy Agency. (2014). Denmark's National Energy Efficiency Action Plan (NEEAP), (April).
- Danish Energy Agency. (2015). The danish energy model. Innovative, Efficient and Sustainable.
- Danish Ministry of Climate. (2012). Accelerating green energy towards 2020. The Danihs Energy. in Danish Ministry of Climate, Energy and Building, (March), 12. Retrieved from http://www.ens.dk/sites/ens.dk/files/dokumenter/publikationer/downloads/accelerating_green_energy_towards_2020.pdf
- Delrio, G. (2013). L'italia dei comuni e la sfida della smart city. in Ecoscienza, 1, 64–65
- Department of Business Innovation and Skills (a cura di) (2013), Global innovator: International Case studies on Smart City, Research Paper 135, in collaboration with Ove Arup&Partners Ltd, London, October 2013
- Fertner, C., Groth, N. B. (2015). Energy-Smart Cities-DK Benchmarking the energy situation of Danish municipalities.
- Fertner, C., et al. (2014). Framework for reports on urban energy planning in 6 case cities.
- Granelli Andrea (2014), Cosa possiamo imparare da Boston Smart City: la tecnologia umanista, 2014, disponibile sul sito
- Granelli Andrea (2013), In Italia batte un cuore <<Smart>> , in "Corriere Comunicazioni" n°20, 2013
- Greater London Authority (eds) (2006), London's Urban Heat Island: A summary for Decision Makers, London, 2006, www.london.gov.uk/major/environment/climate_change/
- Kruger E.L., et al. (2011), Impact of urban geometry on outdoor thermal comfort and air quality from field measurements in Curitiba, Brazil, in "Building and Environment" 46, 2011, pp. 621-634, Elsevier, www.elsevier.com/locate/buildenv
- Madakam Somayya, Ramaswamy R. (2013), State of Art: Smart Cities in India. A Literature Review Report, in International Journal of Innovative Research & Development, 2:12, 2013

• Marie de Paris. (2015a). Paris Intelligente et Durable. Perspectives 2020 et au-delà.

• Marie de Paris. (2015b). Schéma directeur pour la ville numérique 2015-2020.

• Mortensen Jonas, Rohde Jonsbak Frederik et al (2014), Danish Smart Cities: Sutainable living in a urban world. An overview of Danish Smart City competencies, report per Copenhagen Cleantech Cluster, Novembre 2014, Milano, pp.7-9

• Popper Deborah, Popper Frank (2010), Smart decline in Post-carbon cities. The Buffalo commons meets Buffalo, New York, in "The Post Carbon Reader", 2010

• Ramaswamy, R. (2013). The State of Art : Smart Cities in India : A Literature Review Report, 2(12), 115–119.

• Renz Erich. (2015). Business Models and the Creative City : Amsterdam's Knowledge Mile in the limelight.

• The European House-Ambrosetti (a cura di). (2014). Smart Cities in Italy : an opportunity in the spirit of the Renaissance for a new quality of life.

• Viljanen Kim, Poikola Antti, Koponen Pekka (2012), Information navigation in the city, 2012, in Fireball Project FP7 (a report on the city of Helsinki)

Population trends related bibliography

• Buck, N., et al. (2002). Working Capital: Life and Labour in Contemporary London. (Routledge, Ed.). London, UK.

• Engelman, R. (for U. (2009). State of world population 2009. Facing a changing world: women, population and climate. Environment.

• Martine George, Schensul Daniel (eds) (2013), The Demography of Adaptation to Climate Change, New York, London and Mexico City: UNFPA, IIED, and El Colegio de México, 2013

• United Nations Population Fund - UNFPA (eds) (2007), State of the world population 2007. Unleashing the Ptential of Urban Growth, New York, 2007, www.unfpa.org

• Guzman Jose Miguel, Cohen Barney, Perrucci Francesca et al (2013), Population Dynamics in the Post-2015 Development Agenda. Report of the Global Thematic Consultation on Population Dynamics, UNFPA, UNDESA, UN-HABITAT, IOM, 2013

• United Nations Population Fund - UNFPA (eds) (2009), State of the world population 2009. Facing a changing world: women, population and climate, New York, 2009, www.unfpa.org

• United Nations Population Fund - UNFPA (eds) (2010), Population. Situation Analysis, New York, 2010, www.unfpa.org

City of Bologna related publications and reports

• Cascone G. (a cura di) (2015), Il Navile, portolano di città. Racconto di una navigazione dentro al Quartiere Navile, Giraldi Editore, Bologna

• Città Metropolitana di Bologna. (2016). Analisi di contesto città metropolitana. Ambiti territoriali funzionali.

• Comune di Bologna. (2013). PAES piano d'azione per l'energia sostenibile. Retrieved from http://www.millenniumassessment.org/en/Framework.html\nhttp://www.who.int/entity/globalchange/ecosystems/ecosys.pdf\nhttp://www.loc.gov/catdir/toc/ecip0512/2005013229.html\nhttp://www.ncbi.nlm.nih.gov/pubmed/15003161\nhttp://cid.oxfordjournals.org/lookup/

• Comune di Bologna. (2014). Il piano strategico metropolitano di Bologna. Un senso al futuro,

una visione condivisa. Bologna.
• Comune di Bologna. (2015). Profilo Climatico Locale. Analisi delle vulnerabilità all'impatto dei cambiamenti climatici. Bologna.
• Comune di Bologna. (2016). Piano strategico Metropolitano 2.0. Le linee di indirizzo. Bologna.
• Urban Center Bologna, & Comune di Bologna. (2016). Bologna città resiliente. Sostenibilità energetica e adattamento ai cambiamenti climatici (I Quaderni). Bologna: Urban Center.

Main scientific Journals examined

• Techné. Journal of Technology for Architecture and Environment and mainly:
  - Infrastrutture, vol 11, 2016
  - Rigenerazione urbana, vol 10, 2015
  - Tecnologie dell'Architettura. Ricerca e Sviluppo, vol 7, 2014
• ISO Focus and mainly: AA.VV. (2013). Smart cities. in ISO Focus+, 4(1)
• International Journal of Sustainable Development and Planning, https://www.witpress.com/journals/sdp
• International Journal of Sustainable Energy Planning and Management, https://journals.aau.dk/index.php/sepm
• International Journal of Sustainable Development and World Ecology, http://www.tandfonline.com/toc/tsdw20/current

Tecnology, architecture and urban general culture

• Becattini Giacomo, (2015) La coscienza dei luoghi. Il territorio come soggetto corale, Donzelli Editore, Roma
• Benevolo Leonardo (1993), La città nella storia d'Europa, Editori Laterza Roma, Bari
• Buck, Nick, et al. (2002). Working Capital: life and labour in contemporary London. Routledge, 2013.
• Cacciari Massimo (2004), La città, Pazzini Editore, Villa Verucchio
• Dal Lago Alessandro (2004), Non-persone. L'esclusione dei migranti in una società globale, Saggi Universale Economica Feltrinelli
• Di Biagi Paola (a cura di) (2009), I classici dell'urbanistica moderna, Donzelli editore
• Gregotti Vittorio (1966) Il territorio dell'architettura, Universale Economica Feltrinelli
• Gropius W.alter (1955), Architettura integrata, Il Saggiatore Tascabili, Milano edizione 2010
• Mangin David (2004), La ville franchisée. Formes et structures de la ville contemporaine, Editions de la Villette
• Matteoli Lorenzo, Pagani Roberto (a cura di) (2010), City Futures. Architettura, design, tecnologia per il futuro della città. Atti della Conferenza internazionale CityFutures 4-5 Febbraio 2009, Hoepli editore
• Olivetti Adriano (2013), Il cammino della Comunità, Edizioni di Comunità, Roma
• Secchi Bernardo (2013), La città dei ricchi e la città dei poveri, Laterza, Bari
• Semi Giovanni, (2015), Gentrification. Tutte le città come Disneyland?, Il Mulino, Bologna
• Turri Eurgenio, (2000), La megalopoli padana, Marsilio editore
• Zumthor Pether (2003), Pensare architettura, Electa editore

Research methodology related bibliography

• Amaratunga, D., et al. (2013). Quantitative and qualitative research in the built environment: application of "mixed" research approach. in Work Study, 51(1), 17–31. http://doi.org/10.1108/00438020210415488

• Calvani, Antonio (2005). Rete, comunità e conoscenza: costruire e gestire dinamiche collaborative. Edizioni Erickson, 2005.

• Cooper, H. M. (1988). Organizing knowledge synthese: a taxonomy of literature review. in Knowledge Society, 1, 104–126

• Eco, Umberto (2012). Come si fa una tesi di laurea: le materie umanistiche. Giunti, 2012.

• Flick, Uwe (ed.) (2013). The SAGE handbook of qualitative data analysis. Sage, 2013.

• Flick, Uwe (2015). Introducing research methodology: A beginner's guide to doing a research project. Sage, 2015.Semi, Giovanni (2010). L'osservazione partecipante. Una guida pratica (Il Mulino). Bologna.

• Marshall, Catherine; Rossman, Gretchen B. (2014) Designing qualitative research. Sage publications, 2014.

• Neri Serneri Giovanni, (2005), La formazione del ricercatore. Il contributo di un'esperienza, Hoepli, 2006

• Ritchies, Jane, et al. (ed.) (2013). Qualitative research practice: A guide for social science students and researchers. Sage, 2013.

• Sinclair, M. (2007). A guide to understanding theoretical and conceptual frameworks. in Evidence Based Midwifery, 5, 39.

Main PhD and master thesis examined

• Calderoni, Luca (2015) Distributed Smart City Services for Urban Ecosystems, [Dissertation thesis], Alma Mater Studiorum Università di Bologna. Dottorato di ricerca in Informatica, 27 Ciclo. DOI 10.6092/unibo/amsdottorato/6858.

• Catalano Michael A., Appelbaum Alec, Stein Jaime L. (2012), New Yotk City Microclimate Policy. Applying Green Infrastructure to Mitigate Environmental Health Impacts caused by the Urban Heat Island Effect and Heat Waves, Thesis of the Graduate Center for Planning and the Environment, 2012

• Dizdaroglu, D. (2013). A Micro-Level Indexing Model for the Assessment of Sustainable Urban Ecosystems

• Ferraro, Saverio (2013) Smart cities, analysis of a strategic plan. [Laurea magistrale], Università di Bologna, Corso di Studio in Ingegneria gestionale [LM-DM270]

• Mazza, Daniela (2016) Resources Optimization For Distributed Mobile Platforms In Smart Cities, [Dissertation thesis], Alma Mater Studiorum Università di Bologna. Dottorato di ricerca in Elettronica,telecomunicazioni e tecnologie dell'informazione, 28 Ciclo. DOI 10.6092/unibo/amsdottorato/7408

• Piella, Pietro (2013) Digitale dinamico: l'impiego degli Open Data per la costruzione di un modello di analisi finalizzato agli interventi di cohousing. Tesi di Dottorato , Università degli Studi di

Ferrara
• Rauch Nadia, (2014), Architecture and Knowledge Modelling for Smart City. Tesi di dottorato, Università di Firenze, http://hdl.handle.net/2158/957131
• Stajkic, Andrea (2016) IoT and Smart Cities: Modelling and Experimentation, [Dissertation thesis], Alma Mater Studiorum Università di Bologna. Dottorato di ricerca in Elettronica,telecomunicazioni e tecnologie dell'informazione, 28 Ciclo. DOI 10.6092/unibo/amsdottorato/7654
• Testoni, Chiara (2015) Towards Smart City. Amministrazione Pubblica e città italiane di media dimensione: strategie di governance per uno sviluppo intelligente, sostenibile e inclusivo del territorio. Tesi di Dottorato , Università degli Studi di Ferrara
• Yahia Moohammed Wasim (2012), Microclimate and Thermal Comfort of Urban Spaces in Hot Dry Damascus. Influence of urban design and planning regulations, Thesis of Housing Development & Management, Lund University, Sweden, 2012

ATTACHMENTS

The Attachment section includes some complementary documents to the use of the Green Circle Model. In particular, the first Attachment is the Preliminary Checklist. This is a complementary worksheet useful for understanding and reflecting about the general state of the art of the considered district. It is divided into five parts: (1) general information; (2) analysis of district sustainability; (3) district smartness; (4) district resilience; (5) additional challenges, which can be social, economic, etc.

The second attachment is the Target Chechlist. This is a complementary worksheet useful for selecting time-bounded targets. It is divided into the same categories described above: (1) sustainability; (2) smartness; (3) resilience; (4) additional targets.

Figure A1.1 Preliminary checklist of the Green City Circle

n°	Question	Answer
	Theme 1: General information about the district	
1.1	How many inhabitants has the district?	
1.2	What is the density of the district?	
1.3	What kind of district is it, on the functional point of view (mixed-used, residential, commercial, etc.)?	☐ Mixed-used ☐ Residential ☐ Offices ☐ Commercial ☐ Touristic ☐ Productive ☐ Brownfield ☐ Other:
1.4	What specificities the district has on the social point of view?	
1.5	What specificities the district has on the urban point of view (conformation, position, etc.)?	
	Theme 2: Sustainability of the district	
2.1	Are there some NZEB buildings? If yes, how many?	☐ Yes ☐ No If yes, please describe it:
2.2	Is it a low-carbon district?	☐ Yes ☐ No If yes, please describe it:
2.3	Are there applied some measures for mitigation and adaptation to climate change?	☐ Yes ☐ No If yes, please describe it:
2.4	What measures of sustainability the building's sector has?	☐ Active energy efficiency measures (performing systems) ☐ Façade and roofs insulations ☐ PV panels of green energy systems ☐ Performing windows ☐ Other:
2.5	What measures of sustainability the mobility sector has?	☐ EV ☐ E-bikes

		☐ Presence of multimodal mobility network ☐ Presence of park-n-ride systems ☐ Presence of low mobility network ☐ Presence of sharing mobility ☐ Presence of efficient public transport ☐ Other
Theme 3: Smartness of the district		
3.1	Does the district have some smart devices (any kind of)?	☐ Yes ☐ No If yes, please describe it:
3.2	Does the district have some strategies for social smartness?	☐ Living Lab ☐ Educational program ☐ Sharing communities ☐ Other (please specify):
3.3	Does the district have some strategies for grid management?	☐ Yes ☐ No If yes, please describe it:
3.4	Does the district have some monitoring systems?	☐ Air pollution system ☐ Building management ☐ Energy consumption at the district level ☐ Other (please specify):
3.5	Is the city implementing a holistic strategy for smartness?	☐ Yes ☐ No If yes, please describe it:
Theme 4: Resilience of the district		
4.1	Does the district have problems caused by climate change?	☐ Flooding ☐ Heat island

		☐ Heat waves ☐ Drought ☐ Other:
4.2	Is the district, or the city, implementing measures for adaptating to climate change?	☐ Yes ☐ No If yes, please describe it:
Additional challenges		

A1	From the list below, what are the 5 main challenges that you need to face in your district?			
	☐	Fuel poverty	☐	Heat waves
	☐	Microcriminality or delinquency	☐	Heat island
	☐	Organised criminality	☐	Food shortage
	☐	Healthcare problems	☐	Water shortage
	☐	General social challenges	☐	Dis-comfort outdoor
	☐	Absence of services	☐	Absence of spaces for sociality and of play grounds for children
	☐	Absence of eldercare	☐	Dis-comfort indoor buildings
	☐	Absence of educational services	☐	High building energy consumption
	☐	Flooding	☐	Absence of low mobility and green mobility
	☐	Drought	☐	Absence of efficient and sustainable public mobility
	☐	Brownfield presence	☐	High losses (thermal, water) at the district and grid level
	☐	Absence of funding	☐	Challenges on particular spaces related with specific hours
	☐	Absence of people participation on social life and civic engagement	☐	Ecosystem challenges

A2	From the previous list, can you order the 5 main challenges you choose per importance?	
	1	
	2	
	3	
	4	
	5	
A3	Per each challenge, what action (urban, political, social,etc.) do you thing can trigger the change?	
	1	
	2	
	3	
	4	
	5	

Figure A1.2 Target checklist of the Green City Circle

n°	Target	Selection
	Target selection	
0.0	Which time targets do you want to select? Please note that several targets can be selected.	☐ ☐ ☐ 2020 ☐ 2050
	Target 1: Sustainability of the district	
1.1	Percentage of energy savings before 2050	☐ 20% ☐ 30% ☐ 50% ☐ 100% Other:
1.2	Percentage of energy savings before 2020	☐ 20% ☐ 30% ☐ 50% ☐ 100% Other:
1.3	Percentage of energy coming from renewable sources	☐ 20% ☐ 30% ☐ 50% ☐ 100% Other:
1.4	Buildings renovations	☐ Yes ☐ No
1.5	Mobility renovations / improvements	☐ Yes ☐ No
1.6	Air pollution	☐ International targets ☐ More than international targets
	Target 2: Smartness of the district for 2050	
2.1	Implementation of smart devices (any kind of)?	☐ Yes ☐ No
2.2	Implementation of strategies for social smartness?	☐ Yes ☐ No
2.3	Implementation of strategies for grid management / district heating, etc?	☐ Yes ☐ No
2.4	Implementation of monitoring system?	☐ Yes ☐ No
2.5	Is the city implementing a holistic strategy for smartness?	☐ Yes ☐ No
	Target 3: Resilience of the district	
3.1	Implementation of permeable surfaces	☐ Yes ☐ No If yes, please indicate a percentage:
3.2	Implementation of green surfaces / trees	☐ Yes ☐ No
	Additional targets	
	Additional challenges to be addressed:	other | 2020 | 2050

	☐	Fuel poverty	☐	☐	☐
	☐	Microcriminality or delinquency	☐	☐	☐
	☐	Organised criminality	☐	☐	☐
	☐	Healthcare problems	☐	☐	☐
	☐	General social challenges	☐	☐	☐
	☐	Absence of services	☐	☐	☐
	☐	Absence of eldercare	☐	☐	☐
	☐	Absence of educational services	☐	☐	☐
	☐	Flooding	☐	☐	☐
	☐	Drought	☐	☐	☐
	☐	Brownfield presence	☐	☐	☐
	☐	Absence of funding	☐	☐	☐
	☐	Absence of people participation on social life and civic engagement	☐	☐	☐
	☐	Heat waves	☐	☐	☐
	☐	Heat island	☐	☐	☐
	☐	Food shortage	☐	☐	☐
	☐	Water shortage	☐	☐	☐
	☐	Dis-comfort outdoor	☐	☐	☐
	☐	Absence of spaces for sociality and of play grounds for children	☐	☐	☐
	☐	Dis-comfort indoor buildings	☐	☐	☐
	☐	High building energy consumption	☐	☐	☐
	☐	Absence of low mobility and green mobility	☐	☐	☐
	☐	Absence of efficient and sustainable public mobility	☐	☐	☐
	☐	High losses (thermal, water) at the district and grid level	☐	☐	☐
	☐	Challenges on particular spaces related with specific hours	☐	☐	☐
	☐	Ecosystem challenges	☐	☐	☐

ANNEXES

Annexes include some complementary documents and analysis which was created during the research. In particular, three different Annexes Sections are provided.

The first one collects some analytical tables which have been used for framing the first section and, mainly, the analysis of the literature. In particular, they are presented: (1) major climate-related meeting and key moments; (2) some Smart City definitions analysed; (3) definitions of traditional SC sectors; (4) some EU funded projects analysed.

The second Annex collects support instruments of the Bolognina simulation presented in chapter 5. In particular are described: (1) the participative observation; (2) a photographic overview of the district; (3) interviews.

The third Annex collects main activities developed during the three years of research. These activitiies are not directly linked with the research, but they still contribute to the formation of the research.

Annexes Table of contents

Annex I: Research supports

I.1 Summary table of main climate conferences

Table Ann.I . 8 Major meetings linked with sustainability

Name	Year	Findings
Club di Roma Research	1972	The Club of Roma commissioned to the MIT researchers Donatella & Dennis Meadows and Jorgen Randers a study on the energetic condition of the planet. The study took the name of "Development Limits" and denunciated the possible overcome of natural resources. Before this moment resources were considered unlimited.
United Nations Stockholm Conference	1972	Published the Declaration on urban environment in which United Nations start to consider the human load and environment.
World Conservation Strategy (by International Union for the Conservation of Nature and Natural Resources)	1980	Definition of a worldwide strategy for environment conservation.
World Commission on Environment and Development and publication in 1987 of the Brundtland Report	1987	Introduction of the term "Sustainable development" and definition of this development as a global goal. Definition of the Equilibrium Rule of 3E: ecology, equity, economy.
World Conservation Union, UN Environment Programme, World Wide Fund for Nature + Works of Herman Daly	1991	They defined sustainability as the increase of life quality, without exceeding the load capacity of the environment. Herman Daly, in his works, defined three main rules for the future use of resources.
Rio Earth Summit (United Nations Conference on Environment and Development)	1992	Agenda 21 production
ICLEI (International Council for Local Environmental Initiatives)	1994	They defined the sustainability as a development which offers environmental, social and economic services to each component of a community, without overloading the capacity of environmental resources.
Berlin COP 1	1995	This is the first meeting of the UNFCCC, also known as Berlin Mandate. It defined a two years period for analyse and define a panel of actions that member state could have been implemented and chosed for mitigating GHG emissions.
HABITAT II conference in Istanbul	1996	Habitat Agenda production signed by 171 countries
Kyoto protocol (agreed in the United Nations Framework Convention on Climate Change), COP 3	1997	Nations call to action in order to reduce GHG emissions. Becoming effective from 2005, it set a reduction of GHG emissions different for each signatory country.
UNESCO	2001	The UNESCO includes into the definition of sustainability the following concept: the cultural biodiversity is necessary for humanity as the natural biodiversity is for the Earth.
UE Environmental Action Plan 2002-2010	2001	Into the plan were defined 4 primary themes to be addressed: climate change, nature and biodiversity sustainable use of natural resources waste management

Goteborg: 3rd EU Environmental Conference	2001	Published the Goteborg resolution, in which these e elements were addressed: development of policies and legislations on environment process of regional Agenda 21 Greening of structural funds
Monterrey: International Conference for the development finance	2002	Into this conference the main worldwide countries promised to improve their financial effort in order to fight before 2015 poverty, lack of education and epidemics.
FAO World Summit on food	2002	They developed a plan for people health, well-being, for protecting environment, for globalisation and Africa population protection.
World Summit on Sustainable Development in Johannesburg	2002	They developed a development model based on the collaboration among economy, society and environment, able to maintain a society with more equity and wellbeing, also considering future generations.
Italy: Environmental Action Strategy for the sustainable development in Italy	2002	Defined 4 priority areas and related objectives and actions: climate nature and biodiversity environmental quality and life into urban contexts sustainable use of resource and waste management
Aalborg: 4th EU Conference on Sustainable Cities	2004	Aalborg Commitments designed for making more efficient the actions on sustainability and for giving impulse to local Agenda 21.
Bruxelles: EU Strategy for sustainable development	2006	Definition of a specific strategy to overcome the following challenges: climate change and green energy mobility sustainability sustainable usages and productions conservation of natural resources public health demographic and migrations control poverty.
Siviglia: V EU Conference on Sustainable Cities	2007	Siviglia Declaration and Lipsia Chart
Copenhagen Conference of United Nations COP 15	2009	Strong committment among countries in order to mitigate climate change. Several decisions have also been taken in process evaluation and calculation as well as in support the transition with several funds.
Paris Conference of United Nations COP 21	2015	It has been the 11th meeting from the Kyoto Protocol and the 21th annual meeting of the UNFCCC. The Conference decided to limitate up to 2°C the increase of temperature. This means, according to different authors, to become carbon neutral from 2030-2050.
Marrakesh COP 22	2016	The 22th meeting enhanced the decisions assumed during the COP 21 in Paris, by enhancing the role of country cooperation.

I.2 Summary table of main Smart Cities definitions

Table Ann.I . 9 Some definitions of Smart Cities

Definition	Author	Year
Smart Cities: a new concept and a new model, which applies the new generation of information technologies, such as the internet of things, cloud computing, big data and space/geographical information integration, to facilitate the planning, construction, management and smart services of cities. Developing Smart Cities can benefit synchronized development, industrialization, informationization, urbanization and agricultural modernization and sustainability of cities development. The main target for developing Smart Cities is to pursue: • Convenience of the public services; • Delicacy of city management; • Liveability of living environment; • Smartness of infrastructures; • Long-term effectiveness of network security.	SAC – the general working group of Chinese national smart cities standardization	2014
"Smart Cities" is a term denoting the effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens.	BSI PAS 180 provides	2014
A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects"	ITU-T Focus Group on Smart Sustainable Cities	2014
A 'Smart City' is one that [...] dramatically increases the pace at which it improves its social economic and environmental (sustainability) outcomes, responding to challenges such as climate change, rapid population growth, and political and economic instability [...] by fundamentally improving how it engages society, how it applies collaborative leadership methods, how it works across disciplines and city systems, and how it uses data information and modern technologies [...]in order to provide better services and quality of life to those in and involved with the city (residents, businesses, visitors), now and for the foreseeable future, without unfair disadvantage of others or degradation of the natural environment	ISO TMB Smart Cities Strategic Advisory Group uses	2014
The use of ICT [makes] the critical infrastructure components and services of a city – which include city administration, education, healthcare, public safety, real estate, transportation, and utilities – more intelligent, interconnected, and efficient	Washburn et al.	2009
We take the particular perspective that cities are systems of systems, and that are emerging opportunities to introduce digital nervous systems, intelligent responsiveness, and optimization at every level of system integration.	MIT	2013
A city may be called 'Smart' 'when investments in human and social capital and traditional and modern communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance'.	Schaffers et al	2011
S Smart City is 'a city seeking to address public issues via ICT-based solutions on the basis of a multi- stakeholder, municipally based partnership'	EU Directorate General	2014

The “smartness” of a city describes its ability to bring together all its resources, to effectively and seamlessly achieve the goals and fulfil the purposes it has set itself. In other words, it describes how well all the different city systems, and the people, organisations, finances, facilities and infrastructures involved in each of them, are: • individually working efficiently; and • acting in an integrated way and coherent way, to enable potential synergies to be exploited and the city to function holistically, and to facilitate innovation and growth.	ISO	2014
A Smart City is a city well performing built on the ‘smart’ combination of endowments and activities of self-decisive, independent and aware citizens	Giffinger	2007
A city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance.	Caragliu et al	2011
Smart city is defined by IBM as the use of information and communication technology to sense, analyse and integrate the key information of core systems in running cities.	IBM	2010
A city that monitors and integrates conditions of all of its critical infrastructures, including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens.	Hall	2000
A smart city is a well-defined geographical area, in which high technologies such as ICT, logistic, energy production, and so on, cooperate to create benefits for citizens in terms of well-being, inclusion and participation, environmental quality, intelligent development; it is governed by a well-defined pool of subjects, able to state the rules and policy for the city government and development.	Dameri	2013

I.3 Summary table of traditional Smart Cities sectors' definitions

Table Ann.I . 10 Traditional SC sector subdivision definitions. Source: Directorate General (2015)

Sector	Definition
Economy	By Smart Economy we mean e-business and e-commerce, increased productivity, ICT-enabled and advanced manufacturing and delivery of services, ICT-enabled innovation, as well as new products, new services and business models. It also establishes smart clusters and eco-systems (e.g. digital business and entrepreneurship). Smart Economy also entails local and global inter-connectedness and international embeddedness with physical and virtual flows of goods, services and knowledge.
People	By Smart People we mean e-skills, working in ICT-enabled working, having access to education and training, human resources and capacity management, within an inclusive society that improves creativity and fosters innovation. As a characteristic, it can also enable people and communities to themselves input, use, manipulate and personalise data, for example through appropriate data analytic tools and dashboards, to make decisions and create products and services.
Governance	By Smart Governance we mean joined up within-city and across-city governance, including services and interactions which link and, where relevant, integrate public, private, civil and European Community organisations so the city can function efficiently and effectively as one organism. The main enabling tool to achieve this is ICT (infrastructures, hardware and software), enabled by smart processes and interoperability and fuelled by data. International, national and hinterland links are also important (beyond the city), given that a Smart City could be described as quintessentially a globally networked hub. This entails public, private and civil partnerships and collaboration with different stakeholders working together in pursuing smart objectives at city level. Smart objectives include transparency and open data by using ICT and e-government in participatory decision-making and co-created e-services, for example apps. Smart Governance, as a transversal factor, can also orchestrate and integrate some or all of the other smart characteristics.
Environment	By smart environment we include smart energy including renewables, ICT- enabled energy grids, metering, pollution control and monitoring, renovation of buildings and amenities, green buildings, green urban planning, as well as resource use efficiency, re-use and resource substitution which serves the above goals. Urban services such as street lighting, waste management, drainage systems, and water resource systems that are monitored to evaluate the system, reduce pollution and improve water quality are also good examples.
Living	By Smart Living we mean ICT-enabled life styles, behaviour and consumption. Smart Living is also healthy and safe living in a culturally vibrant city with diverse cultural facilities, and incorporates good quality housing and accommodation. Smart Living is also linked to high levels of social cohesion and social capital.
Mobility	By Smart Mobility we mean ICT supported and integrated transport and logistics systems. For example, sustainable, safe and interconnected transportation systems can encompass trams, buses, trains, metros, cars, cycles and pedestrians in situations using one or more modes of transport. Smart Mobility prioritises clean and often non-motorised options. Relevant and real-time information can be accessed by the public in order to save time and improve commuting efficiency, save costs and reduce CO2 emissions, as well as to network transport managers to improve services and provide feedback to citizens. Mobility system users might also provide their own real-time data or contribute to long-term planning.

I.4 EU funded projects: 7th framework program and H2020 framework program

The research aims to give evidence of the process of evaluation not only of real case studies, but also on processes inside EU funded projects. The selection was made querying CORDIS database (http://cordis.europa.eu/home_it.html) to search projects of 7th Work Programme and Horizon 2020 Work Programme. Only projects related with Smart Cities and Communities calls and with sustainable urban planning were analysed. Table Ann.I.4 shows some of the analysed projects.

The main findings, came out with this research, were the following:

1) the projects analysed can be divided with a thematic approach. The 41% focuses on smart city as enabler for increasing city energy efficiency (among them 85% focuses also in framing a methodology for applying the strategies into cities); the 23% focuses more on policies implementation, financial instruments and, in general, in framing instruments; 17% focuses on specific single strategies (e.g. smart grids, waste, water management); 12% focuses specifically in creating models replicable in other cities; finally 1 project focused in giving measures for SCs evaluation.

2) in all the projects several methodologies and approaches are present. Nevertheless in each project it seems to ba a lack in providing simple, clear and precise instrumnenst for improving energy efficiency and climate mitigation and adaptation togheter with clear evaluation indicators. Mainly, projects focus on one or two parts of the whole process: e.g. stakeholders' involvement, refurbishment measures, grids, policies, governance, district approaches, or indicators.

Table Ann.I . 11 EU funded projects analysed

Name of the project	**Cities applica-tions**	**Description**
Cityfied Replicable and innovative future efficient districts and cities	Valladolid, Lund, Málaga, Florence, Napoli, Udine, Ludwigshafen am Rhein	CITyFiED project aims to develop a replicable, systemic and integrated strategy to adapt European cities and urban ecosystems into the smart city of the future, focusing on reducing the energy demand and GHG emissions and increasing the use of renewable energy sources by developing and implementing innovative technologies and methodologies for building renovation, smart grid and district heating networks and their interfaces with ICTs and Mobility.
growsmarter	Stockholm, Koeln, Barcelona	GrowSmarter will demonstrate at 3 lighthouse cities 12 smart, integrated solutions for improve the quality of life for European citizens by better mobility, housing and the quality of urban infrastructure; reduce the environmental impact; create sustainable economic development.

Remourban Regeneration model for accelerating the smart urban transformation	Valladolid, Nottingham, Eskişehir	REMOURBAN aims at the development and validation in three lighthouse cities of a sustainable urban regeneration model that leverages the convergence area of the energy, mobility and ICT sectors in order to accelerate the deployment of innovative technologies, organisational and economic solutions to significantly increase resource and energy efficiency, improve the sustainability of urban transport and drastically reduce greenhouse gas emissions in urban areas.
Triangulum The three point project: demonstrate, disseminate, replicate	Eindhoven, Manchester, Stavanger, Prague, Leipzig, Sabadell	The Triangulum project will demonstrate how a systems innovation approach based around the European Commission's SCC Strategic Implementation Plan can drive dynamic smart city development. We will test the SIP across three lighthouse and three follower cities.
Sinfonia Smart initiative of cities fully committed to invest in advanced large-scaled energy solutions	Sevilla, La Rochelle, Rosenheim, Borås, Paphos, Bolzano, Innsbruck	SINFONIA utilizes EU funds to bolster public/private resources and provide European added value to already committed district refurbishment master plans of middle sized European cities.
Zenn. Nearly zero energy neighbourhoods	Malmö, San Sebastián - Donostia, Stockholm, Trondheim, Oslo	The main challenges of Zenn project is energy renovation processes at neighbourhood scale
r2cities. Regeneration model for accelerating the smart urban transformation	Valladolid, Genoa, Istanbul	R2CITIES aims to develop and demonstrate an open and easily replicable strategy for designing, constructing, and managing large scale district renovation projects for achieving nearly zero energy cities.
Pitagoras Sustainable urban planning with innovative and low energy thermal and power generation from residual and renewable sources	Graz, Bilbao	The project is focused on efficient integration of city districts with industrial parks through smart thermal grids. The overall objective of the project is to demonstrate a highly replicable, cost-effective and high energy efficiency large scale energy generation system that will allow sustainable urban planning of very low energy city districts.
Steep Systems thinking for comprehensive city efficient energy planning	San Sebastián - Donostia, Bristol, Firenze	STEEP project will create a process model based on systems thinking for district energy master planning, which will be applied to 3 city districts to better understand the systems impacting upon energy use and interventions which can be taken to meet the ambitious energy and carbon targets. These models will be enriched and validated through open innovation methodologies applied with the stakeholders.
eu-gugle European cities serving as green urban gate towards leadership in sustainable energy	Vienna, Aachen, Milan, Tampere, Bratislava, Gothenburg, Sestao, Gaziantep	The EU-GUGLE project mobilises public / private resources to build showcases of totally around 226,000 m2 of cost-efficient urban Zero Carbon Building Renovation models

step up Strategies towards energy performance and urban planning	Ghent (Gent), Glasgow, Gothenburg, Riga	STEP UP draws on the partner cities' existing experience of integrated energy planning, building on this through learning and adapting experience from other cities and partners to create a coherent and easy-to-use model for energy planning. This model will be adopted in multiple cities to deliver faster and greater impacts for Europe's 2020 energy targets.
Pleec Planning for energy efficient cities	Eskilstuna, Turku, Santiago de Compostela, Jyväskylä, Vienna, Ljubljana, Copenhagen, Delft, Vilnius, Hamburg, Ruse, Tartu, Stoke-on-Trent, vasteras	PLEEC will gather cities with innovative planning and ambitious energy saving goals. It will identify technology, citizens' behaviors and structure driven efficiency potentials within urban planning and key city aspects. PLEEC will assess the status of energy efficiency and energy flows in the participating European middle size cities.
Transform Transformation agenda for low carbon cities	Amsterdam, Copenhagen, Genova, Hamburg, Vienna, Lyon	TRANSFORM's integrative approach brings operational plans to the strategic level, including strong stakeholder processes, data analytics and takes into account all relevant energy flows, environmental aspects, urban mobility, and the interrelation of possible measures and their costs.
CityKeys Smart City performance measurement system	-	The mission of CITYKEYS is to develop, and validate, a holistic performance measurement framework for future harmonized and transparent monitoring and comparability of the European cities activities during the implementation of Smart City solutions.
ENSCC ERA-NET Smart Cities and Communities	-	The main objective of this ERA-NET is to stimulate successful practice and facilitate replicability within Smart Cities and Communities projects and also across projects in order to achieve a technological shift in the current energy system and provide smart and integrated solutions for technology, government and society.
BlueSCities Blueprints for Smart Cities: developing the methodology for a coordinated approach to the integration of the water and waste sectors	-	BlueSCities aims to develop the methodology for a coordinated approach to the integration of the water and waste sectors within the 'Smart Cities and Communities' EIP.
Insmart Integrative smart city planning	Trikala, Cesena, Évora, Nottingham, Lisbon, Pikermi	The InSMART concept brings together cities, scientific and industrial organizations in order to establish and implement a comprehensive methodology for enhancing sustainable planning addressing the current and future city energy needs through an integrative and multidisciplinary planning approach.

Annex II: Bolognina simulation supports

II.1 Participative observation: being part of Bolognina community

The research on the Bolognina neighbourhood evidenced, at the early beginning of the investigation on the urban context, increasing social constraints and challenges. Several newspapers recorded drugs dealing problems, citizens complaints, micro-crimininality episodes, and so on. For that reason the decision of investigating, in a more detailed way, the social dimension of the district was taken. In order to achieve this insight, the chosen methodology was the Participatory Observation described by Giovanni Semi, in his book L'osservazione partecipante. Una guida Pratica, Il Mulino, 2010. As a complete participatory observation for a complete social analysis would have taken long time and several efforts and as the aim of the analysis was not a complete sociological report, but a beginning of investigation on the district, the research decided to operate the experience only during three months of attendance inside the district.

The experience followed several rules and steps:

- During May, June and July several days have been passed inside the district (2/3 days per week);

- I spoke with several people, mainly on the Albani daily market area;

- I didn't make explicit the nature of my work, but I used a so-called "covered participation approach". In particular, when people asked me about myself I explained that I was a student of the Bologna university or architecture, with the passion of photography and drawing, trying to find a flat inside the district (note that only 1-2 times I needed to explain why I was there, and this happened only at the beginning of the process).

- For each working day I wrote field notes at the end of the day, adding to each field note some keywords, date and recording them on the computer.

At the end of the observation, the analysis of data followed these steps:

- a first reading of all field notes, trying to investigating relevant elements and main social constraints;

- the interview to the president of the district in order to compare visions about sociality in the district (see Interviews on p. 357);

- discussion with the internal and external tutors and definition of the main project for the research.

The following field note is provided as an example of the work done during the Participatory Observation.

Nota di campo del 14/05/2016 - Sabato pomeriggio

Il clima era piuttosto variabile, tra gocce di pioggia e qualche breve schiarita. In Bolognina, nel mercato di via Albani c'era un'inaugurazione di street art: i murales sulle serrande dei negozi all'interno del mercato. Mi aveva invitata il gestore del nuovo bar [ricorda di chiedere il nome la prossima volta], che si ricordava benissimo di me e della chiacchierata che avevamo fatto qualche giorno fa. Sono andata in compagnia di mia cugina per non rischiare di perdere la copertura e per non dare l'impressione di essere sempre sola. In più volevo fare delle foto e ho pensato che andare con qualcuno sarebbe sembrato più normale. Così è stato, varie persone conosciute le scorse volte mi hanno salutata e nessuno mi guardava in maniera particolare, cosa che invece è successa altre volte.

Siamo arrivate a piedi dal quartiere San Donato, partendo dalla zona della fiera, e andando direttamente su via Matteotti e poi su Via Albani. Facendo questa strada ci si rende subito conto di quanto il quartiere sia a portata di mano anche a piedi da diverse aree della città. Più volte ho sperimentato la distanza ravvicinata con il centro storico e la facilità di raggiungere il quartiere attraverso la stazione, ma adesso mi è chiara anche la facilità di raggiungerlo dalla fiera. Forse si potrebbero aumentare le piste ciclabili (?) in modo da connettere tra loro i quartieri, non solo usando il centro come fulcro, ma anche in senso trasversale tra i quartieri. Pensa alla facilità di percorso se ci fosse una pista ciclabile che connette il quartiere alla fiera. Ci abbiamo messo 10-15 minuti.

C'era molta gente all'inaugurazione e molti negozi erano, infatti, aperti.

Molti dei partecipanti erano ragazzi (universitari? Età tra 20-30 anni). La maggior parte di loro era vestita casual, con dettagli etnici e creativi (collane varie, fasce nei capelli, etc.). L'idea che mi hanno trasmesso immediatamente è stata quella di essere in un ambiente intellettuale-urbano-artistico. Avevo avuto la stessa impressione in alcune zone di Copenhagen. In particolare ho notato che quasi nessuno portava i jeans, ma soprattutto pantaloni, un po' larghi, di materiali differenti, ma non di jeans. Molti avevano fasce e foulard nei capelli. Birra in mano o in bicchieri di plastica, sigaretta. Il clima era molto conviviale: gruppi di persone parlavano, un grande via vai all'interno del mercato, qualche gruppo e assembramento negli spazi più aperti. C'erano alcune famiglie e diversi banchetti di associazioni e artisti. Uno dei principali era BAUM [mi hanno dato il biglietto – contattare] Bolognina Arti Urbane in Movimento, che aveva organizzato l'inaugurazione. Mi hanno detto di averci messo un anno, buona parte del finanziamento ottenuto tramite crowdfunding e mi hanno parlato di una collaborazione con Checkpoint Charly e l'Accademia delle Belle arti.

Siamo partite tornando nel bar dove ero stata la settimana scorsa. Il gestore si ricordava benissimo di me. Era molto indaffarato, c'erano infatti molti clienti, ma mi ha comunque rivolto un saluto cordiale e abbiamo parlato del più e del meno. Ho chiesto e pagato due spritz e un amico del gestore si è offerto di offrirceli. Abbiamo rifiutato, ma comunque abbiamo fatto la conoscenza sua e di un altro amico che ci ha raccontato qualcosa in più sul quartiere. Ci ha detto di abitare in via Erbosa [verificare posizione] da molti anni, ci ha detto di avere 54 anni e si è presentato [purtroppo ho dimenticato il nome]. Ci ha parlato di quando "anni fa si poteva girare nel quartiere senza aver paura", mentre "adesso ci sono gli spacciatori all'angolo, dalle 16 del pomeriggio e nessuno fa niente, non ci sono le leggi". Ci ha detto che secondo lui la responsabilità è dello stato, non del comune e che per lui la soluzione sarebbe "la forza". Ha ribadito che "mancano le leggi a livello statale". [nota: questa percezione dell'assenza di responsabilità comunale sarà da investigare. E' una sensazione solo sua o è generalizzata?].

Ha poi aggiunto che "Merola [ha identificato il comune con "Merola", il sindaco attuale] se viene rieletto ci ha promesso di risolvere il problema" vietando la vendita di alcolici dopo le 21 e anche chiudendo i locali che li vendono a quell'ora. Ha detto "come se chiudendo i locali e rendendo buie le strade non si facesse peggio". Ha poi aggiunto che la notte sotto il mercato è tutto buio, quindi lo spaccio viene così permesso. Ha affermato che quando c'era il mercato ortofrutticolo questo problema non esisteva perché "i camion arrivavano presto e c'era un gran via vai".

Ci ha parlato, poi, della strada in cui vive dove afferma che tutti gli scantinati sono affittati abusivamente a prostitute e immigrati clandestini [nota: capire quanto di questo c'è di vero e, se è vero, perché non denunciano la pratica]. "Lo sanno tutti, ma nessuno fa niente. Ci sono delle persone che affittano un appartamento fino a 50 stranieri facendo pagare ad ognuno 250 euro". [nota: sembrava stesse un po' esagerando?]. A quel punto è iniziata l'inaugurazione e abbiamo dovuto stoppare la conversazione.

Alla fine della presentazione sono riuscita a parlare un attimo con Marco dell'associazione BAUM che ha organizzato l'evento e che è molto attiva nel quartiere. Ci ha tenuto a spiegare che l'idea era di fare qualcosa per migliorare il mercatino, senza però farlo diventare "fighetto" [nota: confronta Gentrification, Semi, 2015], ma lasciando che ci fosse la piena partecipazione della comunità, anche in senso attivo. L'idea era quella di rendere il mercatino più attrattivo. Gli ho chiesto se il fatto che molte serrande siano chiuse sia dovuto ad una questione di prezzi, ma lui ha detto che crede sia piuttosto una questione di clientela. Per la sua posizione non ci sono così tante persone che vengono a comprare qui. Secondo lui questo è dovuto ad una mancanza di varietà nell'offerta e di qualità. Ha, infatti, affermato "quando hai solo dei fruttivendoli che si riforniscono dallo stesso fornitore… nessuno che venda un panino o magari anche prodotti di altre culture…". Sembrava molto interessato al tema dell'integrazione culturale perché parlava di vari posti in Europa dove nei mercati questo tipo di integrazione è molto visibile e presente.

Ho cercato di parlare con alcuni ragazzi delle varie associazioni ma erano impegnati e non sono riuscita ad intavolare una chiacchierata interessante. Molti cercavano di fare crowdfunding per le loro attività.

Ho poi conosciuto gli artisti di Checkpoint Charly [perché hanno scelto questo nome?] e sono stata a visitare il loro atelier, che era aperto per l'occasione. Si trova in via Rosaspina, all'interno di un vecchio capannone industriale riconvertito in atelier di co-working. L'ho trovato uno spazio davvero interessante in cui attualmente 5-6 artisti lavorano condividendo la struttura. Lo spazio è suddiviso in vari studioli e alcune zone comuni. In particolare, è suddiviso in due fasce longilinee e parallele tra loro: in quella a destra ci sono i diversi studioli disposti su due piani (il superiore è un soppalco), mentre quella a sinistra è dedicata a spazio comune ed è a tutta altezza. Una delle ragazze con cui ho parlato mi ha spiegato che sono una realtà giovane e che solo da poco hanno trovato un certo equilibrio. Tutti hanno anche un secondo lavoro, perché non riescono a vivere solo della loro arte. Non hanno sovvenzioni né fondi. Stanno cercando di costituirsi come associazione, ma ancora non lo sono a tutti gli effetti. Non sono per ora aperti ad accogliere nuovi artisti (lo spazio, in effetti, non è enorme) ma in futuro sperano di poter affittare a rotazione alcuni degli uffici.

All'ingresso hanno, sul muro principale, una gigantesca mappa della Bolognina e, per l'occasione, ognuno poteva scrivere su alcune cartoline pensieri, ricordi, idee relative ad un luogo del quartiere. Molte cartoline erano appese e ho potuto leggere pensieri molto interessanti ed indicativi. In particolar modo me ne è rimasto impresso uno che diceva "in Bolognina mi perdo sempre"! [nota: identità dello spazio fisico].

Ho lasciato la mia mail. Saranno da ricontattare.

II.2 Photographic overview of the district

This Appendix aims to propose a photographic analysis of the Bolognina district, by underlying some main key aspects:

- buildings typology
- buildings state of maintenance
- quality and quantity of green spaces and urban density
- quality of street canyons
- average image of the district
- sociality.

Bolognina district is part of the bigger administrative entity named Navile and it is located on the north part of the city of Bologna (Italy). During the nineteenth century, the Bolognina district has been an area of expansion and its origins can be traced back to the construction of the central train station in 1856 when the city, historically based on local market, became an important commericla node, at first regional then national and today international. The central station allowed also the development of a massive industrialization process.

The district originally housed food companies, graphics and engineering companies. The sense of identity of the neighbourhood was deeply marked by the massive presence of workers and the population tended to gain a strong sense of community and therefore a strong political vocation. The 1889 Bologna general plan already saw the expansion of the city into this area, with the drawing of square blocks.

During the Second World War the district was an important military target because of the presence of different arms industries. It is after the war that a consistent part of the neighbourhood becomes the home for industry's workers, with the built of more social houses. There was an important community sense in this historical period due to the presence of an important group of workers part of the war Resistance. During the war this group, mainly made by workers, was responsible for different sabotage in the army industries. Those episodes contribute to form an intense social cohesion among people, flowing to the definition of the Bolognina as a working-class neighbourhood after the end of the main conflict. During the 1950's the neighbourhood remains as a vibrant community for the unions demands aiming to give better work conditions. It is only during the 1980's that the social cohesion of the area starts to disintegrate: the closing and the delocalization of some industries, the pressure of speculation as well as the migratory flux start to undermine the social unity of the district.

When the big companies moved away during the 1990s this led to a profound social change, with a partial replacement of typical workers with new ones belonging to the massive immigrant flows. This transformed the district that accounts now approximately 35.000 inhabitants in a very multiethnic district mixing several ethnies (more than 13) and people ages. In particular, due to its proximity to the city centre of Bologna, the district has a growing student population. Actually the neighbourhood is included into the Navile district, which has a territorial extension of 26 km^2 and a population of 66,000 inhabitants (2010 data). The age composition of the whole district is particular, as the young population (from 0 to 14 years old) is about the 11.5% and the elder population (more than 65 years old) is about the 24.1% (2010 data); while the foreign population is more than 11,000 inhabitants (17.1%). The average family composition is of 1,89 person. The average income of families is 19,861 euros but foreign families have lower income (about 9,699 euros) (2008 data). In last 15 years, the Bolognina neighbourhood has seen an important demographic growth (more than 5% in respect to 2001).

Since the beginning of the 2000s, the administration of Bologna has decided to support the regeneration process in the neighbourhood, drawing on its cultural heritage and on the creativity of its inhabitants. This comes at the time when major investments related to mobility and rail infrastructure are being realized in Bolognina, including the expansion of the central train station by Italian national railway company and by the Metropolitan Train Service of the City of Bologna. This is creating an excellent opportunity to explore synergies between top-down infrastructure projects and bottom-up regeneration processes.

Today the district is composed by different typologies of residential housing, both social and normal and its extension goes from the train station to the hippodrome, in the north part of the city. Into this big district there are some specific areas that become of big importance due to the beginning of different actions of requalification. In particular, the boundaries are currently subject of a great transformation:

- because of the new project for the train station, aiming at reconnecting the different parts of the city and creating a new shopping and social area;
- for the presence of the new City Hall building, bringing into the community new people and new flux of interests and sociality;
- for the new urban development nearby the City Hall that brings new typologies of residential houses and new urban quality into the district.

The actual existing Bolognina built environment was mainly built on 1950', even if some courtyards can be dated back 1930'. These last buildings are the oldest of the area and they are characterised by masonry walls. Inside the district, there is a total of 31,569 households; a few part of them (about 1,000) is quite recent (from 2005 to 2010). Some activities are already present for the regeneration of part of the built environment. In particular, the Rigenera project involves stakeholders (the municipality, ACER – public building management company and some Esco) in renovating some building blocks in relation with energy performances. In order to enhance social participation, the neighbourhood has been theatre of the project Convivere Bolognina: a participatory project aiming to define future visions of the district.

Photos present in the following pages are the result of several site visits made during the three years of project. Each photo is correlated with a description and a map showing the position inside the whole district.

Figure Ann.II.1 The project of social housing in Bologna. This is the project of social housing also followed for the Bolognina district after the 1889 General Plan (Piano Regolatore). Source: Renzi (eds.), 1990.

Figure Ann.II.2 The aerial view of the Bolognina neighbourhood analysed into the project (chapter 5). The aerial view puts in evidence the different typologies of building blocks and the main infrastructures.

Figure Ann.II.3 The aerial view of the Bolognina neighbourhood where open spaces are evidenced in black.

Figure Ann.II.4 The picture shows the area of Bolognina behind the space covered by the railway.

Figure Ann.II.5 The picture shows one of the street inside the Bolognina district. The building typology is here evident as well as the presence of the new City Hall building made by the architect Cucinella.

Figure Ann.II.6 Building typologies inside the Bolognina district.

Figure Ann.II.7 Building typologies inside the Bolognina district. The picture also shows the role of cars into the district and the space they need, as well as the current waste management system.

Figure Ann.II.8 The new City Hall Building, created with the project of the Architect Cucinella.

Figure Ann.II.9 Engineer Nervi shelter.

Figure Ann.II.10 Building typologies inside the Bolognina district. The picture evidences the state of maintenance of some buildings.

Figure Ann.II.11 Building typologies inside the Bolognina district.

Figure Ann.II.12 Building typologies inside the Bolognina district.

Figure Ann.II.13 Building typologies inside the Bolognina district.

Figure Ann.II.14 Building typologies inside the Bolognina district. Some buildings are older than tha majority of the built environment. In this case, the building was built in 1930's.

Figure Ann.II.15 Example of internal courtyard. The picture shows one regenerated courtyard.

Figure Ann.II.16 Building typologies inside the Bolognina district.

Figure Ann.II.17 The picture shows an internal courtyard. The majority of current courtyards have not been renovated and the citizens use them mainly as car parks or storage areas.

Figure Ann.II.18 The picture shows an internal courtyard. The majority of current courtyards have not been renovated and the citizens use them mainly as car parks or storage areas. Nevertheless, during summer, they offer interesting shaded areas.

Figure Ann.II.19 The picture shows an internal courtyard. The majority of current courtyards have not been renovated and the citizens use them mainly as car parks or storage areas.

Figure Ann.II.20 Trees and vegetation is present inside the district. However, on streets, all the trees have not wide green areas around them, but just a small one.

Figure Ann.II.21 Trees and vegetation is present inside the district. However, on streets, all the trees have not wide green areas around them, but just a small one.

Figure Ann.II.22 Trees and vegetation is present inside the district. However, on streets, all the trees have not wide green areas around them, but just a small one. The unique exception is in front of the new City Hall building.

Figure Ann.II.23 Via Nicolò dell'Arca. Several street canyons are present on the district. As in the picture, many have two pedestrian side with trees, due car park side and one or two way straffic.

Figure Ann.II.24 Via Carracci. Several street canyons are present on the district. This is the street canyon in front of the train station. It is characaterized by the absence of green surfaces or vegetation.

Figure Ann.II.25 Via Lorenzo Costa. Several street canyons are present on the district. This is one minor street, still characterized by the pervasive presence of cars on both sides. Vegetation and green surfaces are absent, as cycling ways. Pedestrian way is present on both sides, even if with a small width.

Figure Ann.II.26 Via Pellegrino Tibaldi. Several street canyons are present on the district. This is one of the biggest street canyon crossing in the district. It is characterized by the presence of commerces on both side, by car parks and trees.

Figure Ann.II.27 Via del Rosaspina. Several street canyons are present on the district. This is one minor street, still characterized by the pervasive presence of cars on one side. Vegetation and green surfaces are absent, as cycling and pedestrian ways.

Figure Ann.II.28 Via Antonio di Vincenzo. Several street canyons are present on the district. As shown in the picture, many have two pedestrian side with trees, due car park side and one or two way straffic.

Figure Ann.II.29 The neighbourhood has several commerces and sociality spaces.

Figure Ann.II.30 The picture shows an example of one of the present cultural meetings organized by citizens association. This was the opening day of the art exhibition on the mercato Albani.

Figure Ann.II.31 Creativity and street culture are present a lot into the district.

Figure Ann.II.32 People using common space in different ways.

Figure Ann.II.33 Courtyards are often used as storage areas. The lack of identity inside the district led to neglect and inattention episodes.

Figure Ann.II.34 On via Albani a daily market is present. It is one of the main meeting point for the community during the morning, but it is also theatre of micro-criminality and drugs dealing during evening and night.

Figure Ann.II.35 The community on Bolognina is varied both on cultures and income. Several messages of protests can be found on walls. Regeneration projects are often seen as gentrification processes.

Figure Ann.II.36 Creativity and street culture are present a lot into the district.

Figure Ann.II.37 Creativity and street culture are present a lot into the district. In particular, there is a creative group of people, Checkpoint Charly, working on the district. Inside their laboratory they draw a map of the district where people can write messages, ideas or wishes related to specific spaces.

Figure Ann.II.39 Creativity and street culture are present a lot into the district. In particular, there is a creative group of people, Checkpoint Charly, working on the district. Inside their laboratory they draw a map of the district where people can write messages, ideas or wishes related to specific spaces.

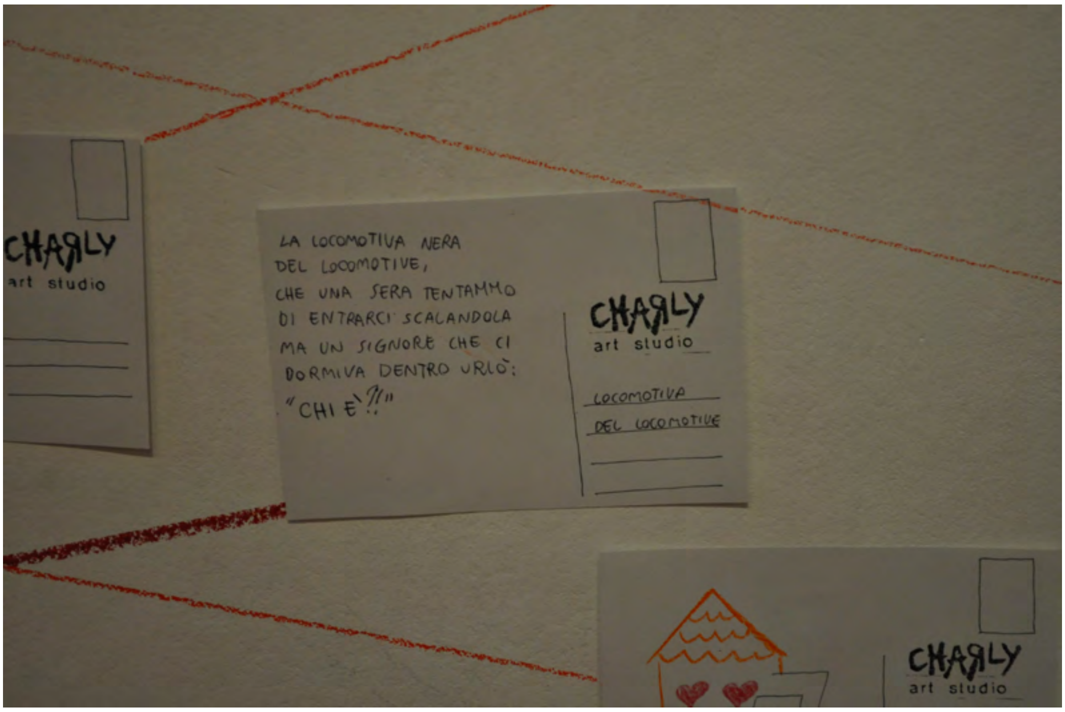


Figure Ann.II.38 Creativity and street culture are present a lot into the district. In particular, there is a creative group of people, Checkpoint Charly, working on the district. Inside their laboratory they draw a map of the district where people can write messages, ideas or wishes related to specific spaces. The picture shows one of the messages.

II.3 Interviews on urban evolution

Two interviews was performed during the research. The first one involved Daniele Ara: the president of the Navile district, where Bolognina is located. The second interview involved Marco Marcatili: the director, for Nomisma, of the Environment, Urban and Agriculture Office.

Interview n°1 with Daniele Ara, president of the district Navile

Researcher: R
Daniele Ara: DA

R: Buongiorno, può gentilmente presentarsi e spiegare il suo ruolo in relazione al quartiere Navile e Bolognina?

DA: Certamente. Io sono l'attuale Presidente del Consiglio di Quartiere e sono stato riconfermato a Giugno per un secondo mandato amministrativo. I quartieri sono degli organismi decentrati del comune e svolgono alcune funzioni proprie, con dipendenti dedicati. Anche se ormai è possibile dire che i presidenti assumano sempre più un ruolo di rappresentanza nei confronti della comunità. Questo è un quartiere di Bologna di oltre di 65 mila abitanti ed è il 6° anno consecutivo che ne sono il Presidente.

R: Quando parla di quartiere, intende il quartiere Navile?

DA: Sì, il quartiere Navile che è composto da 3 aree distinte che hanno una propria identità e che si sono unite nell'1985 con la nuova riforma dei quartieri. Prima i quartieri bolognesi erano 18, poi sono passati a 9 e adesso siamo passati a 6. Dall'85 il quartiere Navile unisce tre zone distinte: Bolognina, Lame e Corticella.

R: Questa unione forzata è stata avvertita in maniera positiva, negativa o indifferente dalla popolazione? Ha comportato delle modifiche sostanziali nel senso di identità e nell'amministrazione delle comunità?

DA: è chiaro che ancora adesso l'identità delle zone e dei rioni rimane: chi abita in queste zone da tanto tempo è legato all'identità territoriale. Però nella pratica nessuno rimpiange più il vecchio presidente di quartiere.

R: Quanto è esteso il territorio del quartiere?

DA: Il territorio va dal Reno al confine con Castelmaggiore, fino a via Stalingrado e alla stazione, quindi è un territorio molto esteso di circa 68 mila abitanti.

R: Un'ultima domanda generale. Il tema della città è molto diffuso in questi anni, sia a livello di politiche pubbliche nazionali e locali, sia in termini di attenzione mediatica. Secondo lei perché c'è questa rinnovata attenzione al tema della città?

DA: Io credo che sia la crisi economica, sia l'esigenza di costruire una società multiculturale abbiano acuito i conflitti già esistenti nella metropoli e che quindi si avverta la necessità di una transizione e di un cambiamento. Da questa crisi devono scaturire nuove politiche urbane che minimizzino i conflitti e che costruiscano la nuova dimensione urbana che non è solo materiale, in senso di qualità urbanistica, ma deve essere soprattutto una qualità dell'abitare dal punto di vista sociale. con una nuova idea di relazioni che abbraccino il tema della multiculturalità e che riguarda tutte le città europee.

R: Scendiamo ora nel dettaglio del quartiere Navile e, in particolar modo, della zona Bolognina: quali sono le caratteristiche di questo contesto urbano anche in relazione al resto della città di Bologna?

DA: Bolognina è una prima periferia, non un'estrema periferia, quindi è vicina al centro storico ma, nonostante questo, ha subìto un cambiamento molto veloce negli ultimi 25 anni: si sono delocalizzate tante attività produttive, dal mercato ortofrutticolo ad una ventina di imprese medio-grandi. Quindi l'identità che si era costruita nel '900 e che era un'identità industriale, con insediamenti commerciali, non esiste più. Il commercio, in Bolognina, rimane ed è sempre stato un aspetto molto importante per la comunità ma, quel tipo di coesione che c'era prima, non esiste più perché non esistono più le fabbriche. Ad esempio le Officine Minganti, che sono andate via, negli anni '50 avevano mille operai suddivisi su tre turni e questo produceva un presidio sociale nel mondo del lavoro che creava un forte elemento di identità. Poi le Aldini e Casaralta, le Cevolani, la Bologna Motori...

R: I vuoti, che il dislocamento o la chiusura delle industrie ha provocato, cosa sono oggi?

DA: I vuoti si stanno riempiendo faticosamente con trasformazioni urbane. Alcune di esse sono governabili, altre meno. I cambiamenti di tipo edificatorio e la capacità di trasformazione di queste aziende non sempre è indirizzabile dall'amministrazione pubblica, però si stanno tutte trasformando, in taluni casi portando dei benefici in termini di servizi per la collettività. In altri casi la trasformazione è più semplicemente una conversione ad abitativo o ad uffici.

R: Quale tipologia di residenti c'è in Bolognina?

DA: di tutto in questo momento. E' una fase di grande mescolamento perché contemporaneamente abbiamo sia la popolazione più vecchia sia quella più giovane della città. Abbiamo una popolazione anziana molto consolidata e sempre più nuove generazioni, con un tasso di implemento demografico molto superiore alla media cittadina. Questo incremento è in parte dovuto a famiglie straniere ma non solo, perché in questi ultimi anni la Bolognina sta attirando giovani coppie di ceto medio che scelgono la zona perché costa un po' meno rispetto ad altre, ha servizi, è vicino al centro, vicino alla stazione e poi sarà collegata anche all'aeroporto con il *people mover.* E' una zona che offre delle opportunità soprattutto in chiave futura.

R: Ci sono anche studenti universitari?

DA: sì, studenti ce ne sono molti, quindi è una popolazione anziana, di giovani coppie, migranti e anche di studenti universitari.

R: ho letto che ci sono circa 13 etnie diverse ...

DA: ce ne sono di più, una trentina. Ho fatto uno studio e, considerando i diversi idiomi cinesi, si parlano circa trenta idiomi diversi.

R: quali sono le problematiche più urgenti secondo lei?

DA: sicuramente la cura del quartiere, proprio nel senso di appartenenza dei cittadini. Poi, di conseguenza, è necessario ottimizzare gli interventi di cura. Il primo passo è però lavorare su un rinnovato senso di appartenenza in senso civico della cittadinanza.

R: l'assenza di senso di appartenenza a cosa è dovuto secondo lei?

DA: secondo me è un insieme di cose. Di certo il cittadino bolognese ha perso alcune caratteristiche che lo contraddistinguevano, soprattutto nella relazione tra comunità e bene comune. Questa caratteristica va recuperata. Poi sicuramente l'inserimento delle comunità straniere necessita di una fase di crescita importante.

R: nonostante questo l'associazionismo sembra abbastanza forte. Ci sono tanti gruppi, anche di creativi come Check Point Charly, l'associazione BAUM. Tutti questi gruppi fanno molte cose e creano momenti di socialità. Come si coinvolge anche il resto della popolazione in queste esperienze?

DA: è una fase molto feconda da questo punto di vista. Il resto della comunità lo si coinvolge costruendo una rete diversificata di associazioni. Il mio impegno principale è quello di fare dialogare le comunità ma anche le generazioni. Centri sociali e parrocchie in realtà aiutano in questa operazione. Bisogna poi trovare dei momenti di condivisione e dei momenti intergenerazionali. Il futuro dovrà essere sempre di più focalizzato sulla connessione e sul trovare nuove progettualità. Il centro Montanari è un esempio in questo e non è un caso che sia in Bolognina. Se fosse stato in zone più statiche sarebbe meno vitale e invece ha dovuto dare risposta a un tessuto sociale che è molto cambiato. E' stato un lavoro faticosissimo e bisogna moltiplicare esperienze di questo tipo.

R: senza entrare nel dettaglio del tema smart, pensa che le nuove tecnologie, intese in senso lato, potrebbero aiutare in questo coinvolgimento urbano oppure lo vede come un elemento tangenziale?

DA: credo che possano aiutare profondamente. Per esempio sarebbe utile una web radio di comunità, gestita dalla comunità. Sono strumenti che possono servire. E' chiaro che bisogna ancora abbassare la tensione rispetto a certi fenomeni acuti che abbiamo avuto. Da un lato c'è bisogno di più cura, poi il problema della tossicodipendenza e dello spaccio è molto serio. Questi sono quei fenomeni acuti che bisogna risolvere e poi passare a progettualità un più smart.

R: se dovessimo fare un progetto urbano integrato, per questo quartiere, quali temi dovremmo puntare a risolvere in maniera prioritaria? quali oggetti? quali porzioni di territorio o tematiche sono prioritarie?

DA: noi abbiamo assolutamente bisogno di uno spazio per la creatività giovanile e questa è una cosa che stiamo cercando e dobbiamo risolvere. Poi il tema della sicurezza stradale intesa come zone del quartiere dove deve essere ridotta la velocità delle auto e deve essere messa in sicurezza l'utenza debole: il pedone e il ciclista. Io mi immagino anche una rivoluzione sulla raccolta dei rifiuti che liberi lo spazio urbano, per esempio con il porta a porta, e che educhi la popolazione alla corretta gestione dei rifiuti.

R: ci sono delle emergenze a livello di sostenibilità ambientale o di resilienza ai cambiamenti climatici nel quartiere?

DA: io penso che dobbiamo aumentare la biomassa verde anche come elemento di mitigazione delle ondate di calore. L'opportunità dell'autostrada tangenziale, del passante di mezzo, crea una opportunità di costruzione di boschi urbani. Non tanto giardini fruibili con giochi, ma proprio boschi urbani mirati alla mitigazione ambientale. Di problemi di quel tipo ne abbiamo tanti da affrontare perché le infrastrutture hanno un ampio impatto ambientale: l'autostrada, l'aeroporto, abbiamo la zona delle cave, la zona nord Lame dove abbiamo il tema di alcune aziende insalubri…

R: sul tema dell'acqua ci sono specifici problemi in questa zona?

DA: non c'è un problema specifico, se non nella irregolarità delle piogge che produce problematiche legate alla qualità del canale Navile.

R: come immagina il quartiere tra 30 - 50 anni?

DA: me lo immagino come un quartiere molto simile ai quartieri europei che hanno saputo investire sul senso di appartenenza delle persone, creando un qualcosa che ancora non c'è, che non c'è mai stato forse in questa città. Credo che questa sarà la vera zona culturale della città, con ricadute sull'economia, da un lato in termini di ricettività di bar, ristoranti e offerta alimentare, dall'altro in termini di multiculturalità. Può essere la zona che attira artisti e studi professionali e, in generale, un ceto medio colto che, per le caratteristiche che dicevamo prima, può fruire dei servizi dall'infanzia, della vicinanza al centro storico, del collegamento con il mondo. Me la immagino così. Ci vorrà tempo ed è chiaro che per adesso bisogna riuscire mescolare i ceti. Questo è un problema perché abbiamo molte etnie di ceti diversi che non si parlano. Il problema dell'immigrazione non è tanto un problema di etnie ma più che altro di ceti diversi che non si integrano tra loro. Infatti, le famiglie del ceto medio, anche straniere, si integrano alla perfezione.

R: come descriverebbe il quartiere in tre parole chiave?

DA: Degrado, fermento e futuro.

Interview n°2 with Marco Marcatili, Nomisma

Researcher: **R**
Marco Marcatili: **MM**

R: Buongiorno, può presentare se stesso e l'azienda per cui lavora, evidenziando i temi principali che oggi siete chiamati ad affrontare?

MM: Nomisma è [una società di ricerca e consulenza economica per imprese, associazioni e pubbliche amministrazioni, a livello nazionale e internazionale, NdA]. E' stata fondata nel 1981 e ha sempre avuto un generale approccio di politica industriale e settoriale. Tra i vari settori di cui si occupava non c'era la città perché la politica industriale era all'epoca percepita più per distretti e per comparti, che in senso urbano.

Oggi le cose sono cambiate. E' possibile affermare che questo mondo è finito perché da uno sviluppo, abbastanza spontaneo, per distretti si è passati ad uno sviluppo, meno spontaneo, per città. Anche i settori non esistono più: oggi non c'è più un'impresa in grado di riconoscersi completamente in uno specifico settore, perché, sempre più, si riconosce contemporaneamente in una varietà di settori, per esempio nei servizi innovativi, ma anche nell'agricoltura e nel commercio. Questo perché oggi un'impresa fa tante cose contemporaneamente e un approccio vincolato alla settorialità non è più attuale. E' come se fossimo passati da un mondo verticale ad un mondo cross-settoriale. E questa interpretazione del mondo è molto complicata perché abbiamo una classe dirigente costruita in senso verticale, gli assessorati che ragionano in verticale e via dicendo. Quindi è un mondo molto verticalizzato mentre la realtà è molto più interdisciplinare e cross-settoriale. Secondo me questo è il tema da affrontare oggi. L'ultimo tavolo di lavoro che abbiamo organizzato si chiama, infatti, built connections. Secondo me all'interno della città mancano i "sarti": mancano le competenze sistemiche, manca questa visione multidisciplinare e soprattutto non ci sono linguaggi in grado di far parlare persone diverse.

In questi ultimi anni Nomisma ha ricevuto molte di queste stesse sollecitazioni perché è un ente di politiche industriali, ma anche un ente privato, che vive di committenze, e molte di esse arrivano da soggetti pubblici o privati che stanno ragionando su come ricreare sviluppo nei territori.

Questa è una domanda a cui noi abbiamo provato a rispondere in maniera molto umile e artigianale perché tuttora manca una letteratura e una strumentazione che ti aiuti in questa nuova tipologia di approccio. E' un po' la logica dell'esploratore, del pioniere.

Io sono responsabile di sviluppo di un'area che si occupa di Immobiliare, Territorio e Ambiente. Abbiamo deciso di inserire questi tre aspetti sotto un'unica area, in quanto prima esisteva l'area Territorio, separata dall'area Ambiente e dall'area Immobiliare. Oggi, aver unificato questi settori in un'unica area ha permesso l'assunzione di una connotazione più ampia: immobiliare perché abbiamo vissuto una fase di espansione delle trasformazioni che non esiste più e quindi bisogna inventare nuove strategie; territoriale perché queste strategie o sono di contesto e di territorio oppure non hanno significato a livello puntuale; e ambientale perché fino ieri è stato concepito come un vincolo ma oggi può essere un driver per generare nuove economie.

Nomisma, poi, è socio di Audis e io sono membro del direttivo di Audis. Lavoriamo molto con progetti nazionali e con Anci, che ci fornisce un po' come una "cartina di tornasole" di tutte le carenze sistemiche che hanno i territori, ovvero grandi esigenze ma scarsa capacità di persone, strumenti e mezzi.

R: Queste carenze sistemiche e scarse capacità di affrontarle sono, secondo lei, più dovute all'assenza di specifiche competenze sui territori o si tratta, piuttosto, una carenza a monte, ad esempio nella ricerca, che non fornisce strumenti di base che i territori possano applicare?

MM: Entrambe le cose, perché dentro i comuni è possibile spesso osservare un sistema di cooptazione avvenuto negli anni passati, per cui non c'è stata una logica di assunzione legata davvero alle competenze. Nei territori, in senso ampio, in teoria queste competenze non mancherebbero però manca la capacità di catalizzarle e non vengono allestiti dei luoghi interessanti dove ciascuno può trovare il proprio interesse e metterlo a fattor comune. Molto spesso, infatti, in quelle città che attivano dei processi, le competenze arrivano in modo più spontaneo. Questo vuol dire che le competenze ci sono. E' necessario dunque fare scouting di competenze, avere la capacità di attivarle e questo richiede una forza da parte dei potenziali soggetti attivatori e che in questo momento non ci sono. E le leve motivazionali non sono sempre economiche.

All'interno di Nomisma stiamo facendo una scommessa: abbiamo capito che l'azienda funzionava bene quando la società si basava sul distretto e c'era bisogno di capire come andavano i settori e le imprese ma oggi occorre passare ad uno sviluppo per città Riteniamo ormai assodato che la città sia la nuova cellula organizzativa dei processi industriali. Le aziende, per esempio, non decidono più di localizzarsi, come in passato, nei distretti industriali perché vicino trovano manodopera, perché oggi la manodopera si sposta ma decidono di addensarsi nelle aree altamente densificate dal punto di vista dei servizi innovativi e di conoscenza. E quindi, da questo punto di vista, le città devono capire in che modo diventare attrattori di servizi innovativi dentro cui poter immaginare una nuova neo-industrializzazione. Nello sviluppo per distretti quello che serviva era una grande individualità imprenditoriale e quello che gli economisti chiamano "animal spirit". Oggi questi due elementi non sono sufficienti per lo sviluppo delle città, perché oggi serve anche grande coralità, invece di individualità. L'asse di sviluppo che passa per la produzione dei beni comuni, che è quello che incarna la città, richiede una coralità produttiva tra le imprese, la capacità di mettersi in gioco e una grande attenzione alla coscienza dei luoghi. Questo è il motivo per cui in alcune città è possibile fare meglio rispetto che in altre.

R: Cosa intendi con "coscienza di luogo"?

MM: Questa è una definizione che ha dato l'economista Becattini. In breve in questa teoria si afferma come il contesto conti ma non solo sul piano del tessuto economico attivo ma anche su quello del contesto culturale. Per esempio, quei territori che hanno più capacità di produrre beni immateriali, o accordi di cooperazione informali, sono quei territori che hanno una coscienza del luogo diversa che ti aiuta a fare città. Per fare impresa bastava l'imprenditore. Se vuoi fare rigenerazione urbana la coscienza del luogo è fondamentale. E' il motivo per cui, prima di fare rigenerazione urbana in un territorio, è necessario chiedersi come parallelamente rigenerare il tessuto sociale e culturale. Una questione è quando una società grande come Enel come Eni o grandi sviluppatori immobiliari, lavorano su città come Milano, dove esiste contesto tale e un mercato per cui hai più libertà di movimento. Ma se si vuole fare rigenerazione urbana una città piccola o media accade spesso che si cali dall'alto un progetto che non ha mercato, fa paura, non serve a quel territorio, è scollato e sconnesso dalle esigenze e dai bisogni reali. Il processo, in questi contesti, deve in primo luogo rispondere alla domanda su come ricreare un processo di rigenerazione e di coscienza di luogo che aiuti a definire il progetto.

R: Allora questa è una strategia per fare nuova economia urbana?

MM: Alla domanda su come fare nuova economia e come ripensare lo sviluppo, la risposta è il laboratorio città. La città, più che il distretto, diventa l'occasione per ripensare a come rigenerare questa economia e come ripensare questo sviluppo. Continuare a pensare per settori e per distretti non aiuta a farci fare passi in avanti e non aiuta la rigenerazione urbana, perché la rigenerazione urbana è un business che non si fa come si faceva un'impresa, ma che risponde a logiche di terzo settore, dove è fondamentale mettere insieme obiettivi collettivi, obiettivi privati, interessi del territorio e interessi di soggetti vari. Alcuni dei temi che vanno affrontati in via prioritaria sono i seguenti: in primo luogo il tema di come ricreare nuove soggettualità che consentano di sviluppare questi progetti. Creare una fondazione di comunità in un territorio perché porti avanti la rigenerazione urbana non è facile, richiede un'alta coscienza di luogo. E se questa coscienza non l'hai costruita prima, la rigenerazione urbana non è possibile farla.

Se pensiamo, qual è il processo che mi aiuta a costruire coscienza di luogo? A costruire un progetto innovativo e a fare evolvere le idee del territorio e a costruire la procedura? Chi è il soggetto che mi consente di farlo? In quale assessorato vado? Chi sono queste persone? Quali competenze? Ad oggi non esiste nulla di simile e, attualmente, è necessario costruirselo caso per caso. E' solo la logica del pioniere, che però è rischiosa.

E' come se noi avessimo vissuto un modello di economia veloce dove riuscivi a stabilire quali erano i ritorni e quali erano gli effetti, a un processo di economia lenta. I soggetti che hanno fatto l'economia veloce, ci hanno dato ricchezza, ci hanno fatto star bene ma ora si apre il mondo dell'economia lenta che ha bisogno di nuovi soggetti, imprese e anche di nuovi soggetti pubblici. Io metterei la rigenerazione urbana dentro un contesto di economia lenta nuova. Questo è il nuovo contesto dove non si può fare un piano economico finanziario con tassi di interesse al 12% ma bisogna mettere un tasso di interesse al 4%; dove i soggetti che fanno quel piano economico finanziario non sono uno solo ma sono dieci; dove ci vuole un nuovo soggetto giuridico che coordina questo processo; dove probabilmente il piano economico finanziario non è fatto solo di numeri ma è fatto anche di risultati qualitativi da mettere in conto, perché la rigenerazione urbana, è vero, crea meno economia tradizionale ma quanta nuova economia crea? E allora è su questo nuovo punto di vista che bisogna ragionare.

R: Tutte queste nuove soggettualità di cui stiamo parlando si inseriscono nel contesto più ampio del tema della città. Le città di ogni sono chiamate a rispondere a quali problemi specifici, secondo lei?

MM: Quando noi pensiamo alle città molti pensano direttamente al sindaco o al comune. E proprio questo è da modificare perché la città è qualcosa di più di un concetto amministrativo: la città è fatta di soggetti di sviluppo, di cui uno è il sindaco, un altro la giunta, ma non è solo questo. Se devo fare una progetto per una città non guarderei tanto, come molti ancora fanno, all'elezione del sindaco o agli anni di lavoro di una giunta. Questo è un modo di vedere la città passato. Per guardare la città, oggi, io andrei a vedere diversi altri fattori: quanto quella città è capaci di allestire luoghi corali, quanto è capace di fare co-progettazione, quanto è capace di costruire coscienza. Lì per me è il terreno fertile. Poi si devono valutare tutte le competenze e si va a vedere quelle che le città già possiedono; quindi si analizzano quali questioni la città deve affrontare.

R: Più nel dettaglio quali sono i principali problemi che queste città vi mostrano?

MM: Una serie. In primo luogo, nelle città è possibile vede un differenza molto ampia tra sviluppo potenziale e sviluppo attuato. Hanno delle distanze enormi e colmare questa distanza non è facile. Il secondo elemento che vedo è che queste città consumano ma non producono. Quando si pensava alla rigenerazione urbana, fino a ieri, si pensava a fornire delle funzioni residenziali, delle funzioni commerciali, delle funzioni di una città che consuma. Ma immagina che la città sia un'impresa. La prima domanda che l'impresa si fa è come creare valore.

Quel processo "rigenerativo" per funzioni crea valore? Che valori crea?

Vedere la città non più come entità che consuma ma come città che produce e che co-crea valore non è banale: pensare quali possano essere le nuove funzioni di un'area di un quartiere nell'ottica non solo del servizio e del commercio ma anche della produzione di valore. I comuni fino a ieri si sono visti come centri in cui bisognava spendere molto per migliorare la qualità dei servizi. Chiedere alle città di ripensarsi, in questo nuovo fenomeno di neo-industrializzazione, non è semplice.

Un'altra cosa che vedo mancare è la seguente: le città sono sottodimensionate in termini di beni d'interesse collettivo. E' come se avessimo vissuto una fase di espansione e di trasformazione che ha perseguito tantissimi interessi privati ma pochissimi interessi collettivi. Osservando le città si nota spesso subito una grande capacità di edificato ma spesso una mobilità disastrosa, spazi relazionali scarsi, funzionalità e servizi quasi assenti. E' come se avessimo spostato tutto l'interesse di queste città su alcuni obiettivi che, non voglio dare un giudizio di valore, ma erano obiettivi privatistici, che non avevano un disegno strategico.

R: Quindi possiamo dedurre che una delle prime cose che manca è proprio la capacità di avere una visione ampia da parte della città per se stessa e, di conseguenza, manca anche una visione nel lungo termine?

MM: Il processo che dobbiamo mettere in campo deve essere dinamico: il momento della visione non è separato dal momento dell'implementazione. Non è più possibile ragionare pensando di studiare per due anni una visione per una città e poi implementarla nei 10 anni successivi. La visione ti aiuta a capire alcune cose subito che ti aiutano poi a riconfigurare la stessa negli anni. E' come una spirale che ti permette istantaneamente di rinnovare azione e visione. Avere visione è più una forma mentale ovvero è la capacità di mettere gli interventi in relazione ad un piano che man mano si rinnova a seconda dei cambiamenti. Tutti hanno la sensazione che questo debba farlo il sindaco. Siamo passati da una fase in cui la città l'hanno fatta i privati ad una fase in cui si pensa la debbano fare i sindaci. Non è così. C'è una socialità, un mondo del privato sociale da ricostruire e per quello servono soggettualità nuove in grado di comprendere le dinamiche e di metterle in relazione. Quando parliamo di processi rigenerazione chi ci immaginiamo al tavolo del discorso?

R: Può nominarli?

MM: La gran parte dei territori quando pensa a questi mondi pensa alla filiera delle costruzioni, allargata alla filiera della manifattura e dell'impiantistica. Pensa cioè molto alla dimensione hardware. Mentre oggi siamo parliamo maggiormente con il mondo software. Allora è come se noi dovessimo immaginarci nuovi soggetti di software, più vicini a tutto quel mondo del terzo settore che è un mondo che fa anch'esso economia perché sanità, ambiente, cultura fanno tutte parte del terzo settore, ma che, nello sviluppo dei territori non viene spesso considerato.

Come incrociare questi mondi che individualmente perseguono obiettivi anche diversi ma che sono tutti interessati a fare attività economiche? Il problema è che questi mondi non vengono messi insieme anche perché spesso si nota come manchino linguaggi comunicativi comuni. Il problema è che non ci sono competenze sistemistiche che consentano di mettere attorno ad un tavolo queste persone. Ma non perché non esistano, ma piuttosto perché manca un disegno generale che permetta alle competenze di operare relazioni e collegamenti.

Due ulteriori questioni da risolvere sono le seguenti: in primo luogo quella delle periferie. Non solo quelle fisiche ma anche quelle tipologie di periferie meno visibili, più economiche ed esistenziali e meno geografiche che sono presenti nei contesti urbani. E, se sulla rigenerazione non ci sono strumenti, qui ce ne sono ancora meno. Molti nemmeno le vedono. Anche se è un tema urgente ed interessante.

R: Sì, è un tema che mi interessa anche per ricerche future. Il caso della città Smart può aiutare in queste tematiche, secondo lei?

MM: Un aspetto positivo della Smart City è che ha focalizzato l'attenzione su che tipo di infrastrutturazione deve avere oggi una città per migliorare la quotidianità dei cittadini, per migliorare la qualità di chi fruisce la città ma non ci vive, per attrarre nella città nuovi produttori e quindi questo tema dell'infrastruttura, che non è solo strade ma è piuttosto quale disegno dell'infrastrutturazione della città ci deve essere. Su questo vedo grande potenziale.

Abbiamo citato due termini: ora la Smart City e prima, più spesso, la rigenerazione urbana, può dare una definizione dei due termini e spiegarne la differenza?

Un po' la riflessione sulla Smart City sembra stia passando ma è chiaro che è stata una riflessione utile perché ha riportato nelle agende politiche il dibattito sulla città. Se ha avuto un beneficio è questo. Il problema, a mio parere, è che non lo ha posto in maniera corretta, come se la tecnologia dovesse risolvere tutto. Chi sta dentro un'impresa sa bene che può investire il 100% del fatturato in tecnologia ma che questo non basta, perché ci sono molti altri elementi da considerare: processi organizzativi, un tema di governance, un tema di qualità della produttività. La produttività non è data solo dalla tecnologia.

Da questo punto di vista trovo che una riflessione utile sarebbe traslare il tema della città smart verso due concetti: uno è la Sensible City e uno è la città micro-politana.

La riflessione sulla SC è vero aiuta sull'implementazione tecnologica in ambito urbano ma nulla dice sul ruolo che la città centroide ha nei confronti del territorio. Quando parliamo di sviluppo delle città in realtà stiamo parlando di uno sviluppo di una città-territorio più ampia. I comuni piccoli, infatti, non vedono l'ora che alcune città centroidi partano con progetti di sviluppo che le includano. Allora SC intesa come un comune grande che fa un progetto con una grande azienda su un'area al territorio più ampio non interessa, o comunque non aiuta allo sviluppo di un disegno più generale.

L'altro tema che credo sia interessante sviluppare è spostare il tono dalla tecnologia per arrivare ad una città Sensible che ha, sì un'attenzione alla tecnologia come capacità di avere delle antenne sulla città che ti aiutano a raccogliere dati e a produrre politiche diverse, ma che è anche sensible rispetto alla comunità e alle persone. Cioè una città che metta al centro la persona e quindi il miglioramento della qualità di vita . Questa è una definizione che mi piace di più perché dentro c'è anche un'attenzione alla vita. Mentre in SC, per ora, io non vedo questa inclusione.

R: Anche io trovo che molte applicazione della città smart siano parziali. Infatti, nel mio lavoro, cerco di dare una definizione diversa di smart city che non sia così tanto ancorata all'implementazione tecnologica digitale. E' anche vero questa tecnologia che può comunque essere un elemento abilitante (un enabler), ma non è detto che lo sia in tutti i contesti e non è detto che ti permetta di ottenere i risultati fissati.

MM: In Italia, i tavoli e i documenti che parlano di SC non sono quelli che parlano anche di rigenerazione urbana: sono due mondi completamente separati. Da questo punto di vista bisogna non creare il terzo mondo ma metter insieme questi mondi e quello che puà metter mettere insieme questi due mondi è andare verso un concetto di Sensible City allargato ad un discorso più territoriale.

R: Prima di passare a chiederti cosa intende più nel dettaglio con rigenerazione urbana, prima ha citato la città micropolitana. Cosa intende esattamente? La trovo un'espressione interessante su cui secondo me ci sarebbe molto materiale di lavoro. Il ragionamento sulla SC ha funzionato per un periodo, ma questo ragionamento necessita di essere portato avanti e vedo nel territorio un buon campo di evoluzione.

MM: La SC ha avuto il merito di rimettere in pista il tema della città e, di conseguenza, di portare la riflessione su queste aree marginali, di far capire che ci sono dei bacini e dei giacimenti di valore anche sulle aree periferiche. Oggi stiamo creando nuove città metropolitane, con tutte le difficoltà del caso, perché ragioniamo su città da almeno 300.000 abitanti In Europa che ne sono 40, noi ne stiamo creando 14, per cui un elemento di riflessione deve essere portato avanti.

Tuttavia l'80% del territorio italiano non è un territorio di metropoli. Allora abbiamo voluto lanciare questa riflessione: se recuperiamo la definizione di città micropolitana forse aiutiamo a condensare un po' l'interesse su uno sviluppo fatto di elementi e obiettivi diversi, con una riflessione sulle relazioni istituzionali, sulle funzioni e i servizi.

R: Può darmi una definizione di rigenerazione urbana?

MM: Credo che questa riflessione venga fuori dal nostro passato urbano: abbiamo vissuto una fase di grande espansione in cui abbiamo costruito molto, spesso male, poi una fase di trasformazione perché volevamo trasformarlo. Adesso che non c'è mercato, ci viene chiesta rigenerazione urbana. Allora rigenerazione urbana, per come la vedo io, è spostare l'attenzione dagli oggetti ai soggetti, operando una rigenerazione di chi abita la città, che si chiede quali siano i propri fabbisogni e i propri desideri. E quindi la rigenerazione passa prima da un disegno esistenziale della comunità, poi da un disegno di visione e infine dal disegno degli oggetti. Questo è mancato negli anni '70 perché non serviva un disegno emotivo esistenziale futuro. Ho conosciuto il settore calzaturiero e nessuno pensava a fare un'analisi degli utilizzatori finali. Si producevano ciabatte e la gente le chiedeva. Non c'era bisogno di un disegno mirato. Mentre qui siamo in un contesto storico in cui è necessario porsi delle domande di senso. Per cui la rigenerazione la vedo maggiormente legata a scelte di senso piuttosto che a convenienze. E in questo sta la differenza tra modelli di espansione e modelli di rigenerazione. I modelli di trasformazione ed espansione erano modelli in cui la coerenza era data dall'attinenza ai piani regolatori. Avevi una pianificazione, un piano economico finanziario e dei sistemi di convenienza, razionali e oggettivi.

Oggi non c'è niente di razionale e di oggettivo. Questo è il cambiamento. Come se dalle convenienze oggettive si sia passati a convenienze di senso.

Chi è il giudice per decidere se una cosa ha senso o no? E' la comunità.

E' come se la comunità si dovesse dotare di strumenti per capire se una cosa ha senso o no. Allora per portare la comunità ad operare queste scelte, è necessario effettuare dei processi in cui è la comunità che deve esprimere i propri bisogni e desideri, ovviamente attraverso un accompagnamento e una guida.

In un certo senso, il termine urbano andrebbe inizialmente tolto e la rigenerazione associata più ad un termine come, per esempio, smart communities e coscienza di luogo. In altri termini, è la rigenerazione di questa coscienza che ti permette di avere l'indicatore di convenienza per fare un certo progetto. Dove c'è questo si riesce a fare progetti di rigenerazione urbana. Ed è il motivo per cui tutti i soggetti pubblici che sono stati creati per rigenerare le città, in realtà non hanno prodotto nulla. La ANRU invece (Agéncie Nationale de Regénération Urbaine), l'agenzia della rigenerazione urbana francese, ha prodotto molta rigenerazione perché, intanto gli sono stati dati vari miliardi come dotazione, e poi perché nei loro servizi prevendono due funzioni: 50% delle competenze svolgono servizi di attivazione di processi collettivi e scelte di senso e il 50% lavora la parte hardware.

R: Voi a Nomisma avete una forte esperienza di collaborazione con le realtà locali, con le città e i sindaci, cosa queste realtà vi chiedono più di frequente? Che tipo di supporto? Quali sono le loro necessità, carenze, potenzialità che possiedono quando si tratta di intervenire sulla città?

MM: E' una domanda ambiziosa. L'80% del mio lavoro è costruire la committenza ed educare la committenza. Se dovessi aspettare loro che mi chiedono qualcosa si fa molta fatica.

Una miccia però c'è ed è: 1) "non so da dove prendere i fondi" oppure "aiutami a costruire un piano di sviluppo" 2) "devo prendere i soldi dall'Europa" oppure "mi aiuti a fare dei progetti" eccetera.

R: Quindi un approccio molto contingente? Emergenziale quasi? O mirato a recuperare fondi da qualche altra parte.

MM: Sì, un approccio emergenziale. Quando succede, noi cerchiamo di indirizzare la committenza verso una riflessione più larga, che parta dall'esigenza specifica allargandola verso un disegno strategico. Anche i nostri servizi ultimamente si sono spostati, non tanto a consegnare un prodotto o uno strumento, ma ad attivare un processo dentro cui i territori trovano man mano le risposte. Accompagnarli, assisterli, questo è il nostro nuovo obiettivo.

Lo strumento ITI ha aiutato molto perché è un processo che aiuta a trovare risposte a delle esigenze immediate, perché nell'ITI bisogna indicare anche degli investimenti reali nei prossimi 3 anni, e poi ti porta ad attivare delle relazioni con il mondo dei privati. E quindi ti aiuta a fare stare insieme due esigenze: l'esigenza, a volte anche elettorale, con l'esigenza di una visione strategica che rompa i confini amministrativi e quelli elettorali. Tutto questo processo non è facile e spesso si trovano delle resistenze.

R: Abbiamo parlato delle carenze che avete osservato nei territori: abbiamo parlato di approccio alla coralità, di nuove soggettualità in grado di fare da cerniera.. C'è qualcos'altro che secondo lei manca come strumento, anche

pratico di attuazione o a livello normativo o progettuale?

MM: Sicuramente, un po' più di competenze sistemiche andrebbero ricercate e premiate. All'interno dei comuni avviene ancora poco, perché la logica è quella dei settori.

Un altro elemento che manca è il mondo della finanza. Mi sembra che ci sia stata una prima fase in cui c'è stato un coinvolgimento immediato degli attori amministrativi, poi, bene o male, il mondo sociale e culturale è stato stimolato e vedo grande coinvolgimento anche del mondo privato evoluto. Ma quando si arriva a parlare del mondo della finanza, questi sono ancora alla finestra. La scusa è spesso che "la banca fa la banca", però se il mondo della finanza non si reinterpreta dentro un concetto meno sportellistico, ma essa stessa porta un contributo rispetto a come questi processi, li vedo come attori mancati e quindi come grande carenza per il processo urbano.

Se io stessi cercando un finanziatore per un mio progetto, il finanziatore lo trovo solo se gli garantisco un rendimento. Ma, oggi, non cerco quello, perché non potrò mai garantire un rendimento. Io devo cercare un socio, io cittadino o sindaco o privato sto cercando un socio ideale per costruire sviluppo futuro. E perché la finanza non può essere questo socio ideale per costruire uno sviluppo futuro anche non mettendoci risorse finanziarie? Bisognerebbe sperimentare di più nuove strumentazioni di comunità. Secondo me dobbiamo dimenticarci il soggetto finanziatore perché se sono in grado di costruire consenso su un certo progetto, sono anche in grado di raccogliere soldi, per esempio dalla comunità stessa. Oggi ci sono progetti di crowdfunding che funzionano molto bene. I comuni, poi, possono farsi assistere dalle banche locali per lanciare delle obbligazioni di scopo. Oppure esistono i social impact bond.

R: A livello normativo cosa possiamo dire? Quali sono le leggi nazionali che potrebbero aiutare questi processi? Cosa si può fare a livello legislativo per aiutare i territori a fare questo tipo di processi?

MM: Per me non ci potrà mai essere una legge sulla rigenerazione che potrà affrontare tutto questo ma una legge che obblighi alcuni soggetti, in particolar modo pubblici, a fare determinate cose, anche su campi più piccoli, può aiutare.

R: Intende degli obblighi per attuare azione che possano poi crearne altre a cascata?

MM: Si, ma piccoli elementi. Per esempio, ogni anno dovremmo riqualificare il 3% della nostra superficie pubblica, secondo le direttive europee. E' un piccolo segnale però, secondo me, può aiutare, perché i territori si devono chiedere come fare e gli creerà anche un problema, ma essendo un obbligo sono obbligati a ragionarci.

D'altro canto molti vincoli esistenti non rispondono più alle reali necessità dei territori, quindi bisognerebbe anche avere la forza di abbandonare molti vincoli, secondo un approccio più ragionato.

R: Se dovesse dare 3 o più parole chiave che possano fornire una chiave di lettura per indirizzare il processo di trasformazione e per definire la città del futuro cosa direbbe?

MM: Processo. La città non è mai un progetto ma è sempre di più un processo, che si apre, non si chiude e si rinnova.

Comunità. La città è comunità.

Impresa. Mi piace anche immaginare la città come impresa. Ho una buona concezione dell'impresa, in quanto ha intrinseche capacità di combinare talenti, di costruire visioni progetti e questo re-immaginare la città come una impresa, che si chiede come produrre valore, come creare valori, come attrarre produttori, come co-creare valore, insomma, mi piace.

Sensible city. Una città che può essere anche locale, però connessa. In altri termini mi piace l'idea che queste città abbiano delle reti lunghe anche rispetto ad altre città che affrontano problemi simili con cui possano confrontarsi. Questo è un atteggiamento tipico delle persone, lo fanno anche le imprese, non riesco a capire perché non riescano a farlo anche le città.

Annex III: PhD related experiences

III.1 Outline of Climate KIC label experience: the Journey project

The PhD is Climate KIC labelled. During the three years of research, I have participated not only to the University of Bologna didactic program but also to the Climate KIC one. In particular, I have participated to the following main activities:

- PhD Summer School in Rotterdam (AA 2014-2015)
- PhD Summer School in Bologna (AA 2015-2016)
- The Journey Summer School (AA 2015-2016)
- several one-day events, lectures and SPARK! lectures.

Each experience contributed to the formation of this research in several ways. In this Appendix, a summary of the Journey project is provided as the project developed during the Journey constitutes one of the basis of the present research.

Name of the project: PLAN IT

Group composition: Vincent Bellinkx, Saveria Boulanger, Sven Djokic, Jérémie Jaeger, Simon Matter, Nanja Nagorny

Executive summary:

Plan-IT is a software platform built to simplify the implementation of climate change decisions in urban planning.

Thousands of cities in Europe are designing climate change strategies and this number is continuously on the rise. However, their implementation is often challenging. In municipalities, climate change managers are not trained to use technical urban planning softwares - this results in a lack of communication between climate and urban planning on the one hand, and architects offices on the other. Moreover, municipalities are not fully aware of the whole range of existing green solutions for their city.

Plan-IT attempts to solve this problem by providing an innovative, user-friendly software to municipalities designed to facilitate communication and technical dialogue with the suppliers of products and services, as well as citizens. With a simple “drag & drop” system, the user can experiment their projects by adding several urban-planning items to their district map and check simultaneously the impact they have on their budget and climate change targets. The user will also be inspired by a range of best practices from other municipalities and companies.

In order to accelerate the use of Plan-IT among urban planners in Europe, the software is free of charge for municipalities. It is financed by cooperating companies such as project developers, consultants and providers of green technologies and infrastructures to whom we offer an effective solution based advertising and lobbying channel.

The market is buoyant and growing. There are approximately 100,000 municipalities in Europe. Ten percent of these municipalities are currently implementing a climate strategy and can thus be considered as our targeted market. We aim at reaching one percent of this market (100 municipalities) within 2-3 years. A larger number could then be reached after received feedback has been considered and needed improvements have been made. Market size is marketing spending of project developers and technology providers towards public institutions. Within this market Plan-IT targets companies that are keen on offering services and products to municipalities.

The capital requirements are € 175,000 to maintain liquidity until the company starts to turn in a profit. In accordance with the projected revenue, it will start being profitable in year 4 and the break even point is expected to occur at the end of year 5. The investors’ buyout will be € 600,000.

The exact quantification of Plan-IT’s climate impact will depend on the number of municipalities implementing the software. However, as municipalities can experiment and evaluate the mitigation and adaptation impacts of their urban planning decisions, they will be able to make the most efficient and effective decisions in line with their climate plan. Plan-IT thus bridges the gap between the targets set by municipalities and their implementation. A widespread use of the software can effectively serve to address climate change by both adapting cities to its effects and mitigating their emissions.

Background and Challenges

Thousands of European Municipalities have set themselves ambitious Climate Change targets to reduce Greenhouse Gas Emissions. Partnering up in EUs Covenant of Mayors more than 6.000 municipalities have voluntarily committed themselves to reduce their carbon emissions by 20% till 2020. Other municipalities like Copenhagen, Frankfurt or Helsinki are even more ambitious and want to become carbon neutral by 2025 or 2050. Visions, targets and strategies to make this transition happen are in place, but in the practical implementation of real projects municipal climate change managers face several barriers. These long-term targets remain therefore often abstract and are difficult to communicate to technical experts that are in charge of realising the projects on the ground, to colleagues from other departments, to citizens or other stakeholders like local businesses.

Value Proposition and Solution

Urban Climate Change policy makers have therefore the need for tools that facilitate communication and technical dialogue with project developers and suppliers of products and services as well as citizens. As municipal climate change managers have to be generalists they are often not fully aware of the whole range of existing green solutions, especially related costs and quality aspects. Plan-IT provides a tool which enables non-technicians to visualize and test out different solutions how to make their individual climate change strategies happen. The tool allows them to easily see the impact of different solutions on their climate change targets by showing the range of the possible emission reduction combined with additional qualitative data (like adaptation benefits and further explanations) on the specific solution. At the same time the budget is roughly calculated based on average costs of the chosen solution. Last but not least the user gets informed which company may be suitable to realise the project. During the phase of experimenting with different kind of solutions to the given problem a list of good examples from other European municipalities serves furthermore as a source of inspiration. As the financial resources in most European municipalities are limited and climate change policies still are a voluntary municipal task in the end of the pre-planning phase the user of the software is going to be informed about different funding schemes (European, national, regional) he or she can apply for to realise the pre-planned project and which kind of consultancy is available.

Prototype Showcase

Step 1: Upload your district 2D image

- Upload your 2D image and draw with a simple polyline the boundaries of your district.

- Wait for the transforming process in 3D (the software recognises all buildings and streets)
- Click on each building (or group of buildings) and select the main features (typology of roof, main materials, m^2, etc...). You just have to fill in a simple format.

Step 2: Now you have your 3D sketch! Set your target

- Now you are ready to set your target: your budget and your main CO_2 target.
- You can also set your milestones into the Milestones and time page

Step 3: Start to try with the drag and drop system and build your vision

- When you drag and drop features from the menu on the right, look at the

target menu on the bottom, to know how it impact on your budget and on the carbon emissions.

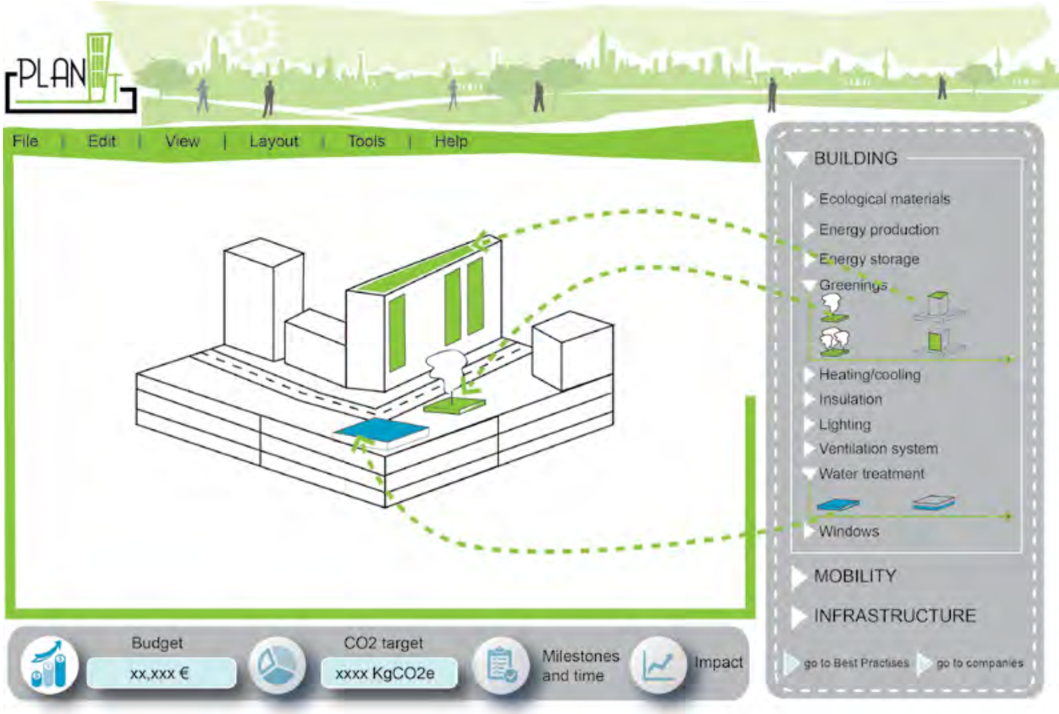
- Click on the Impact button to see the impact of your project.

Step 4: Look at the Best Practises to be inspired

When you drag and drop features a pop-up window appears to show you different Best Practises. Be inspired and, if you need, you will find contacts.

Step 5: Now you have your visual strategy

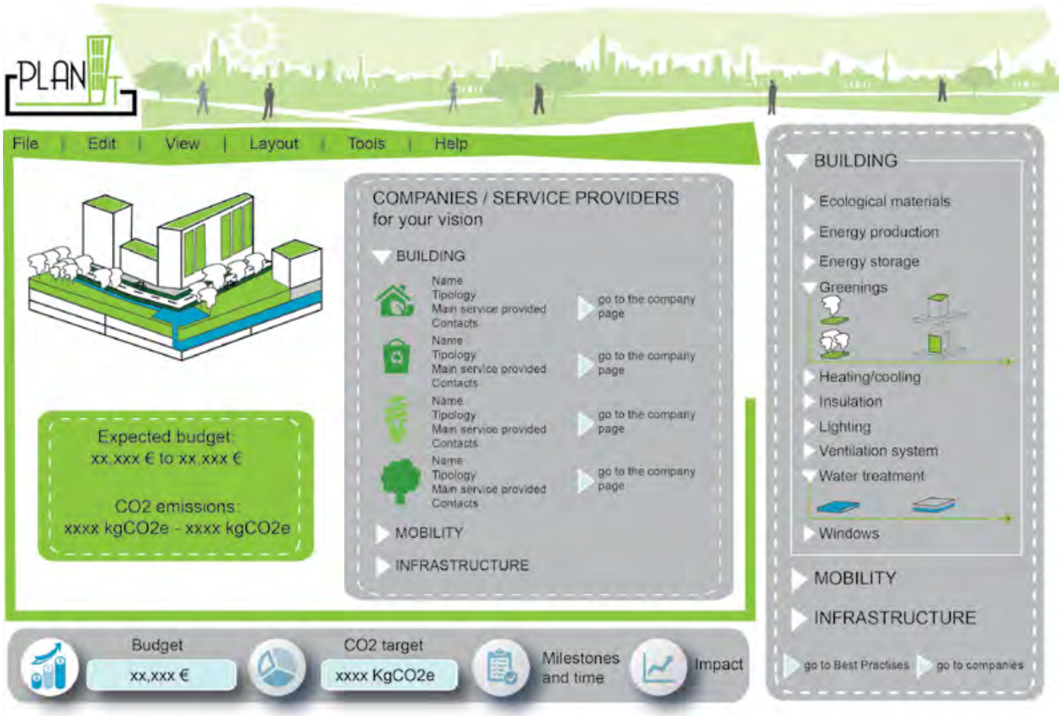
- When you have finished, just push on the Finish to design button and you will see your final visual strategy.



- You can print the image, or send it to stakeholders, colleagues, technicians, etc..

Step 6: Look at the Companies and Services Providers

- When you have finished you can access to a updated list of companies and service providers, that are linked with your own vision.
- You can click on them and see some projects and information.



III.2 Abstract of Legislation proposition on Smart Cities in collaboration with Fondazione Cultura Democratica

During the three years of PhD, the researcher has founded and actively participated to the Foundation Cultura Democratica (http://www.culturademocratica.org). The association groups together Italian innovators under 35 years old, which aim to give ideas and have a voice into the national development of innovative legislations. In particular, we work together with thousands students, PhD and university professors in order to propose innovative legislation in several field on government. The specific role of the researcher is of responsibility under the topic of cities and territories. Following it is possible to read, in Italian, the main legislation proposed to the Italian Parliament and actually under discussion inside the Parliament, about Smart Cities implementation.

The legislation is aimed at accelerating the process of implementing innovative experiences in the field of cities.

Depositato presso la Camera il 1 febbraio 2016 a firma dei Deputati Fregolenti, Arlotti, Bargero, Bonomo, Braga, Capodicasa, Carella, Censore, Cominelli, Crivellari, Dallai, Marco Di Maio, Fedi, Cinzia Maria Fontana, Gasparini, Iori, Lodolini, Manzi, Marchetti, Martella, Patriarca, Petrini, Piazzoni, Scuvera, Senaldi, Taricco, Vico

(Atto Camera n. 3571 – Legislatura XVII)

Onorevoli Colleghi! – L'utilizzo delle potenzialità della rete e delle più innovative tecnologie per la gestione delle aree urbane rappresenta l'elemento cardine per l'attività di governo, attuale e futura, delle città e dei territori.

Il quadro normativo vigente, tuttavia, non consente l'individuazione di un efficace modello di coordinamento delle eterogenee iniziative intraprese a livello locale, causando una dispersione nelle iniziative di innovazione ed un'evidente difficoltà per gli enti territoriali nell'accesso alle risorse finanziarie necessarie a sostenere questi fondamentali progetti di sviluppo dell'intera comunità.

La presente proposta si pone pertanto l'obiettivo di ricondurre ad unità le più diverse iniziative intraprese in materia di Smart Cities attraverso la previsione di un'efficace sistema di governance, che si configuri anzitutto nella individuazione di una struttura di coordinamento, che abbia una funzione di direzione, supporto e monitoraggio dei processi di innovazione; un sistema innovativo di organizzazione e coordinamento delle Smart Cities (come specificato dall'articolo 1 dedicato alle finalità per provvedimento) che sia attuato nel rispetto dei principi costituzionali di sussidiarietà, differenziazione ed adeguatezza nonché di equilibrio di bilancio.

Viene poi proposta (al capitolo 2) una nuova definizione di Smart Cities che indica "i luoghi e/o i contesti, riferiti agli enti territoriali di livello comunale, metropolitano ovvero di area vasta, nei quali siano stati avviati processi di innovazione ovvero siano stati adottati sistemi tecnologici finalizzati alla gestione innovativa delle risorse e all'erogazione efficiente di servizi integrati".

Viene quindi sancito che le iniziative di sviluppo e di innovazione intraprese interessano necessariamente non solo l'area urbana ricompresa nell'ente comune ma anche le aree circostanti che possono essere incluse nella realtà metropolitana o comunque di area vasta, così come oggigiorno denominata dal legislatore, enti che sono titolari di importanti competenze in materia, specialmente a livello di programmazione e pianificazione territoriale.

Affinché il sistema possa funzionare correttamente, vi è la necessità di ripensare il modello di governance prescelto di modo da renderlo efficace. Viene quindi proposta l'istituzione (al capitolo 3) dell'Unità Nazionale per lo Sviluppo delle Smart Cities presso il Dipartimento per il Coordinamento Amministrativo della Presidenza del Consiglio dei Ministri, con il compito di definire strategie ed obiettivi attraverso un Piano nazionale triennale nonché coordinare il relativo processo di attuazione, con particolare riferimento agli standard tecnici ed il reperimento delle risorse economiche.

La definizione di strategie ed obiettivi da parte dell'Unità deve avvenire, in ogni caso, nel rispetto del riparto delle competenze tra Stato e Regioni. Ne consegue la necessità di individuare strumenti di raccordo che consentano di coinvolgere le Regioni, principalmente mediante il ricorso a procedure di consultazione e concertazione che possono trovare concretizzazione nel sistema delle Conferenze.

L'Unità, relativamente agli aspetti tecnici, sarà coadiuvata da un Comitato Tecnico per le Smart Cities, istituito presso L'Unità Nazionale per le Smart Cities, il quale si occuperà della regolamentazione tecnica dei progetti innovativi. Questo Comitato sarà costituito modificando la composizione e le funzioni già previste dall'Agenzia per l'Italia Digitale per il Comitato delle Comunità Intelligenti.

Viene sancita, inoltre, l'istituzione del Registro delle Smart Cities, cui possono accedere tutti gli enti territoriali che abbiano già adottato o che intendano implementare sistemi di innovazione. Questo Registro si aggiunge a quanto già realizzato attraverso la Piattaforma "Italian Smart Cities" sviluppata dall'Anci (Associazione Nazionale Comuni Italiani), sulla base del lavoro di analisi dell'Osservatorio Smart City, la quale mappa, raccoglie e cataloga gli interventi progettuali smart presenti sul territorio nazionale.

La necessità di integrare le diverse iniziative già presenti sul territorio nazionale e la volontà di favorire lo sviluppo di nuove progettualità, armonizzando l'utilizzo delle risorse disponibili, sono i due elementi fondamentali che hanno condotto ad un'ulteriore proposta, ossia l'introduzione del Piano Nazionale per lo Sviluppo delle Smart Cities (inserito all'articolo 3, comma 1, lettera c).

Quest'ultimo è stato delineato come uno strumento di indirizzo per gli enti territoriali che individua le linee guida da seguire nello sviluppo dei progetti di innovazione e, soprattutto, definisce le cosiddette aree prioritarie o ambiti di intervento per l'implementazione delle tecnologie ritenute innovative. La proposta prevede che la redazione del Piano Nazionale per lo Sviluppo delle Smart Cities sia affidata all'Unità Nazionale, con cadenza triennale e decorrenza a partire dal 31 dicembre 2016. In dettaglio, si è ritenuto necessario che l'Unità Nazionale predisponesse il Piano attraverso un processo di collaborazione con gli altri attori istituzionali i cui ambiti di intervento sono correlati ai temi della qualità della vita e servizi al cittadino, sviluppo del tessuto imprenditoriale e sostenibilità economica, sociale ed ambientale.

Successivamente, all'articolo 4 della presente proposta di legge, vengono istituiti i Distretti Urbani di Innovazione Sperimentale, finalizzati alla sperimentazione di tecnologie innovative su circoscritte porzioni di territorio delle Amministrazioni locali. A tale scopo si è ritenuto opportuno regolamentare il rapporto tra l'iniziativa privata di innovazione sperimentale e gli enti territoriali. Al fine di predisporre e realizzare, in un contesto sperimentale, singoli progetti innovativi, i soggetti privati interessati potranno unire le proprie risorse finanziarie e le proprie competenze nello sviluppo tecnologico ed industriale in enti societari quali: Consorzi, Società per Azioni e Società a Responsabilità Limitata.

La partecipazione dell'ente territoriale in qualità di socio nei Distretti Urbani di Innovazione Sperimentale è tendenzialmente di minoranza ed il ruolo ricoperto è di rappresentanza, consultazione e, in parte, di monitoraggio.

La valorizzazione del territorio è, come noto, scopo principale che deve essere perseguito dagli enti locali. Si tratta, tuttavia, di un obiettivo cui non rimane totalmente estranea l'attività delle Università, che, attraverso l'investimento nella ricerca e nello sviluppo, anzitutto culturale, delle giovani generazioni, sono tra i principali attori del processo di implementazione del territorio. E' pertanto necessario realizzare una più fattiva cooperazione tra questi due diversi soggetti dell'ordinamento (presente all'articolo 5), che, titolari di autonome e differenziate competenze, possono avere obiettivi comuni, la cui realizzazione deve essere agevolata attraverso la promozione degli strumenti giuridici più opportuni.

Uno strumento al tempo stesso efficace ed economico può apparire la stipulazione (inserito all'articolo 6) di un accordo per disciplinare attività di interesse comune, accordo che costituisce una specificazione degli accordi tra pubbliche Amministrazioni già disciplinati dall'articolo 15, legge 7 agosto 1990, n. 241, oppure l'istituzione di apposite fondazioni cui partecipino sia le Università che gli enti locali, fondazioni che debbono declinarsi come fondazioni di partecipazione deputate allo svolgimento di attività strumentali alla didattica ed alla ricerca, fini primari cui, come noto, deve tendere l'attività delle Università.

Pertanto, l'obiettivo che ci si pone, con l'evidente intento di promuovere forme di partenariato pubblico-pubblico, tenendo in considerazione anche gli spunti che il legislatore europeo ha fornito con le direttive appalti del febbraio 2014 (si vedano, in particolare, i considerando 31, 32 e 33 nonché l'articolo 1, co. 6 e l'articolo 12, direttiva UE 26 febbraio 2014, n. 24), è quello di giungere ad una legge, composta da pochi ed essenziali articoli, che consenta di delineare la disciplina giuridica più opportuna per gli accordi e le fondazioni in questione, con quest'ultime che si dovrebbero porre, dati i soggetti coinvolti, tra gli attori principali del processo di rinnovamento dell'intero sistema Paese.

L'importanza di questa iniziativa è strettamente collegata allo sviluppo delle nostre realtà territoriali quali le Smart cities; è, difatti, evidente che un contesto territoriale che voglia definirsi "intelligente", anzitutto dal punto di vista della sostenibilità economica ed ambientale, non può prescindere dall'instaurazione di uno stretto rapporto di collaborazione con il mondo della ricerca e, dunque, anche sotto questo aspetto si deve sottolineare l'importanza di una legge che consenta una promozione degli strumenti di cooperazione tra Università ed enti locali.

L'articolo 7 specifica poi che dall'attuazione della legge non debbano derivare nuovi o maggiori oneri a carico della finanza pubblica, mentre l'articolo 8 indica le disposizioni finali.

Articolo 1 (Finalità)

1. La presente legge reca disposizioni in materia di sviluppo, organizzazione e coordinamento delle Smart Cities, nonché in materia di implementazione e sperimentazione sui territori delle tecnologie, e cooperazione tra enti locali ed Università, nel rispetto dei principi costituzionali di sussidiarietà, differenziazione ed adeguatezza nonché di equilibrio di bilancio.

Articolo 2 (Definizioni)

1. Ai fini della presente legge, per Smart Cities si intendono i luoghi e/o i contesti, riferiti agli enti territoriali di livello comunale, metropolitano ovvero di area vasta, nei quali siano stati avviati processi di innovazione ovvero siano stati adottati sistemi tecnologici finalizzati alla gestione innovativa delle risorse e all'erogazione efficiente di servizi integrati.

2. I processi di innovazione di cui al comma 1 devono prevedere espressamente l'utilizzo di tecnologie di gestione territoriale che sfruttino le potenzialità della rete e della connessione Internet per una gestione integrata e ottimizzata delle Smart Cities quali spazi fisici e sociali.

Articolo 3 (Unità Nazionale per lo Sviluppo delle Smart Cities)

1. E' istituita l'Unità Nazionale per lo Sviluppo delle Smart Cities, di seguito denominata Unità, presso il Dipartimento per il Coordinamento Amministrativo della Presidenza del Consiglio dei Ministri, con il compito di assicurare il coordinamento dei processi di innovazione e di sviluppo delle Smart Cities. A tal fine l'Unità, sentito il comitato tecnico di cui al comma 2:

a) definisce, previa intesa con la Conferenza Unificata Stato-Regioni-autonomie locali, strategie, obiettivi e ambiti prioritari di intervento atti a garantire lo sviluppo omogeneo sul territorio nazionale delle Smart Cities;

b) istituisce, con apposita deliberazione, e gestisce il Registro delle Smart Cities, altresì definendo i requisiti e le modalità per l'iscrizione al medesimo Registro;

c) predispone ogni tre anni, con decorrenza a partire dal 31 dicembre 2016, il Piano Nazionale per lo Sviluppo delle Smart Cities, individuando le linee guida e gli standard tecnici e finanziari da seguire nello sviluppo dei processi d'innovazione e nell'adozione dei sistemi tecnologici di cui all'articolo 2,;

d) verifica la conformità dei processi d'innovazione e dei sistemi tecnologici adottati alle linee guida e agli standard tecnici stabiliti dal Piano Nazionale di cui alla lettera c);

e) valuta l'impatto delle misure indicate nel Piano Nazionale di cui alla lettera c) e redige un rapporto annuale sul loro stato di attuazione e sull'effettivo conseguimento degli obiettivi indicati dal citato Piano;

f) provvede al monitoraggio dell'attuazione dei processi di innovazione e dell'adozione dei sistemi tecnologici, anche avvalendosi dei dati e della collaborazione dell'ISTAT e degli enti appartenenti al Sistema statistico nazionale (SISTAN);

g) fornisce assistenza tecnica e supporto al fine di individuare le opportunità di finanziamento dei processi di innovazione, mediante forme di partenariato pubblico-privato, fondi strutturali europei e fondi nazionali;

2. E' istituto presso l'Unità nazionale per lo sviluppo delle Smart Cities il Comitato tecnico per le Smart Cities, formato da nove componenti in possesso di particolari competenze e di comprovata esperienza nel settore delle Smart Cities, di cui uno designato dal Dipartimento della funzione pubblica della Presidenza del Consiglio dei Ministri, due designati dalla Conferenza permanente per i rapporti tra lo Stato, le regioni e le province autonome di Trento e di Bolzano, uno designato dall'Associazione nazionale dei Comuni Italiani, cinque dal Direttore generale dell'Agenzia per l'Italia digitale. Il Comitato adotta il proprio regolamento di organizzazione ed elegge il Presidente. L'incarico è gratuito, ha durata triennale e non è rinnovabile, salvo che per i membri appartenenti all'Agenzia.

3. Con decreto del Presidente del Consiglio dei Ministri, su proposta del Ministro dello sviluppo economico, di concerto con il Ministro dell'economia e delle finanze e con il Ministro Semplificazione e la Pubblica Amministrazione, sentita la Conferenza permanente per i rapporti tra lo Stato, le regioni e le province autonome di Trento e Bolzano, da adottare entro sei mesi dalla data di entrata in vigore della presente legge, sono individuate le modalità di composizione, organizzazione, e funzionamento dell'Unità nazionale per lo sviluppo delle Smart Cities nonché le modalità di attuazione delle disposizioni di cui al presente articolo.

Articolo 4 (Strumenti per l'implementazione e la sperimentazione sui territori delle tecnologie utili per lo sviluppo delle Smart Cities)

1. Per le finalità di cui alla presente legge, gli enti territoriali possono:

a) stipulare patti e accordi di innovazione con imprese, enti pubblici e privati di formazione e ricerca, associazioni e organizzazioni della società civile, aventi ad oggetto la sperimentazione o l'installazione su porzioni di territorio urbano di tecnologie innovative, senza alcun corrispettivo a carico degli enti territoriali per la cessione di beni e servizi dalle imprese partecipanti, fatta salva la possibilità di concedere l'utilizzo a fine promozionale di spazi e beni pubblici;

b) partecipare, per una quota non superiore al 49 per cento del capitale sociale, a Distretti urbani di innovazione sperimentale (DUIS), costituiti in forma di Consorzi, Società a responsabilità a limitata o Società per azioni, ed aventi ad oggetto esclusivo la progettazione e/o la realizzazione di interventi di innovazione urbana all'interno di una predefinita porzione di territorio, nel rispetto degli strumenti urbanistici vigenti, al fine di implementare i servizi al cittadino e la fruizione dello spazio urbano;

Articolo 5 (Campus di innovazione sperimentale)

1. Le università possono stipulare con le imprese e gli enti territoriali accordi per l'istituzione di campus di innovazione sperimentale, con lo scopo di semplificare ed accelerare la collaborazione reciproca al fine di sviluppare tecnologie innovative che offrano concrete soluzioni a specifiche questioni pubbliche. La direzione del campus è concertata tra imprese ed università, tramite la costituzione di un apposito organo amministrativo.

2. La direzione del campus di innovazione sperimentale stabilisce un programma di lavoro compartecipato tra imprese e università, che preveda l'attuazione della sperimentazione in maniera preponderante negli spazi fisici del campus stesso. A tal fine gli enti territoriali si impegnano, con le università, a trovare gli spazi fisici adeguati alla creazione del campus stesso, favorendo l'utilizzo di aree dismesse o di locali limitrofi alle università. E' fatto esplicito divieto all'ente locale di richiedere un affitto per l'utilizzo degli spazi ai fini didattici e di sviluppo delle tecnologie concertate tra università ed imprese.

3. Ai fini dello svolgimento delle attività di ricerca nel campus, anche mediante la costituzione di un apposito fondo, l'università si impegna a conferire spazi, risorse finanziarie nella quota stabilita nel contratto, nonché risorse umane e scientifiche. Le imprese partecipanti si impegnano a fornire risorse finanziarie, attrezzature, materiali e competenze manageriali, nonché ad istituire assegni di ricerca industriali e di assegni di dottorato, nel numero minimo di uno per ciascuna impresa, con l'obiettivo di sviluppare competenze tecniche e applicate funzionali all'attività di ricerca sviluppata nel campus di innovazione sperimentale, per i quali le università si impegnano a gestire l'amministrazione e la pubblicazione dei bandi di concorso. L'ente territoriale si impegna a fornire supporto amministrativo e a favorire lo sviluppo di tecnologie che rispondano a problemi concreti della realtà urbana di riferimento. Le attrezzature conferite al campus di innovazione sperimentale dai soggetti partecipanti sono vincolate all'attività di ricerca del campus

stesso fino al termine della sperimentazione sancita dal programma di lavoro di cui al comma 2.

Articolo 6 (Fondazioni di partecipazione)

1. Le Università possono costituire fondazioni di diritto privato, ai sensi dell'articolo 59, comma 3, della legge 23 dicembre 2000, n. 388, e successive modificazioni, secondo le modalità ivi previste, al fine di acquisire beni e servizi indispensabili alle proprie esigenze alle migliori condizioni esistenti sul mercato, nonché per lo svolgimento delle attività strumentali e di supporto alla didattica ed alla ricerca.

2. Alle fondazioni di cui al presente articolo possono partecipare soggetti privati e pubbliche amministrazioni interessati a prender parte a progetti di ricerca volti alla valorizzazione del territorio e caratterizzati da un elevato tasso di innovazione scientifica e tecnologica.

3. Le fondazioni di cui al presente articolo hanno sede nel territorio del comune ove è la sede legale dell'Università.

4. Le fondazioni di cui al presente articolo perseguono i loro scopi con tutti gli strumenti consentiti dalla loro natura giuridica. In particolare, le fondazioni possono:

a) promuovere la raccolta di fondi pubblici e privati;

b) stipulare contratti, intese o accordi con soggetti pubblici e privati;

c) sostenere lo svolgimento di attività di formazione, ricerca ed innovazione tecnologica;

d) partecipare a consorzi, associazioni o fondazioni che condividono le medesime finalità, nonché ad enti di ricerca in Italia ed all'estero;

e) promuovere seminari, conferenze anche con altre istituzioni ed organizzazioni nazionali ed internazionali.

Articolo 7 (Disposizione finanziaria)

1. Dall'attuazione della presente legge non devono derivare nuovi o maggiori oneri a carico della finanza pubblica.

Articolo 8 (Disposizioni finali)

1. È abrogato l'articolo 20, del decreto-legge 18 ottobre 2012, n. 179, convertito, con modificazioni, dalla legge 17 dicembre 2012, n. 221.

2. I rapporti giuridici in essere dipendenti dall'attività comunque svolta dall'Agenzia per l'Italia Digitale mantengono efficacia sino al 31 dicembre 2016. Entro il termine di cui al presente comma, il Presidente del Consiglio dei Ministri disciplina, con proprio decreto, le modalità di coordinamento tra le iniziative già intraprese sulla base dell'abrogato articolo 20 del decreto-legge 18 ottobre 2012, n. 179 e le disposizioni della presente legge.

III.3 Summary of main scientific and EU proposals contributions

Riviste scientifiche (peer reviewed)

Boulanger Saveria O.M., La Smart City come processo integrato per lo sviluppo urbano, in Ufficio Tecnico, n°4, anno 2015, ISSN 0394-8293, pp 10-15

Boulanger Saveria O.M., Smart City: Utopia o realtà? Comprendere l'evoluzione per comprendere la Smart City, in FA magazine, n°33 vol. VI, luglio-settembre 2015, ISSN 2039-0491, pp. 24-33

Giacchetti, Tommaso; Boulanger, Saveria; Gallo, Valentina, ART 5 DEL " COLLEGATO AMBIENTALE, LEGGE DI STABILITÀ 2014. Visione, programmazione e risorse per la mobilità sostenibile, in Innovazione & Riforme, n°1, 2016, ISSN 2499-1775

Antonini Ernesto, Gaspari Jacopo, Boulanger Saveria O.M., (in press) Multi-layered design strategies to adopt smart district as urban regeneration enabler, in International Journal of Sustainable Development & Planning

Boulanger Saveria O.M., Nanja Nagorny, (in press) Replication vs mentoring: Accelerating the process of spreading good practices for the low-carbon transition, in International Journal of Sustainable Development & Planning

Atti di convegno

Farinella Romeo, Boulanger Saveria O.M., Ronconi Michele, Il "metrobosco" per San Pietro in Casale: "un buon posto per vivere", Atti della XVI Conferenza Nazionale SIU, Napoli, 9-10 Maggio 2013, in Planum. The Journal of Urbanism n°27 vol2/2013

Boeri A.; Boulanger S.; Gaspari J.; Longo D., Smart buildings and grids in the renovation of the built environment, in: World Sustainable Building 2014, Madrid, GBCe, 2014, 5, pp. 255 - 262 (atti di: World Sustainable Building 2014, Barcellona, 28-30 ottobre 2014) [Contributo in Atti di convegno]

Antonini Ernesto, Gaspari Jacopo, Boulanger Saveria O.M., Multi-layered urban strategies to foster the smart cities development, in The Sustainable City X, WIT Press, 2015, ISSN 1743-3541 (10th International Conference on Urban Regeneration and Sustainability, 2015, 1-3 September, Medellin, Colombia), Editors: Brebbia C.A., Florez-Escobar W.F, pp. 23-34

Capitolo di libro

Gaspari, Jacopo; Boulanger, Saveria; Gianfrate, Valentina; Rosa Schiano, Phan, SMART DISTRICTS AS A CLIMATE RESPONSIVE STRATEGY FOR URBAN REGENERATION, in: Central Europe tovards Sustainable Building. Innovations for sustainable future, Prague, Grada Publishing Czech Technical University in Prague, 2016, pp. 521 - 528 [capitolo di libro]

Riviste generiche

Boulanger Saveria O.M., Legno, verticalità e sostenibilità. Anche l'Italia inaugura il suo primo grattacielo in legno, in Legno Legno News n°53, anno 2015, ISSN 2279-8765

Boulanger Saveria O.M., Tempo e Architettura. Le esposizioni universali come teatro di innovazione: i padiglioni in legno di EXPO 2015, in Legno Legno News n°54, anno 2015, ISSN 2279-8765

Boulanger Saveria O.M., La casa per studenti tra prefabbricazione e sperimentazione, in Legno Legno News n°55, 2015, ISSN 2279-8765, pp.60-67

Boulanger Saveria O.M., La casa galleggiante tra design e necessità. Le floating house come esempio di transizione verso città resilienti? , in Legno Legno News n°56, anno 2016, ISSN 2279-8765

Boulanger Saveria O.M., Artigiani e botteghe. Tra storia e modernità, in Legno Legno News n°57, anno 2016, ISSN 2279-8765

Riviste online

Boulanger Saveria O.M., Le Smart Cities di ICityLab, in architetturaecosostenibile.it

Boulanger Saveria O.M., Il portico di San Luca a Bologna è icona di solidarietà, in architetturaecosostenibile.it

Boulanger Saveria O.M., Report Smart Cities 2016. La riconferma di Bologna, in architetturaecosostenibile.it

Partecipazione a progetti:

PROPOSAL - H2020-EeB-2015 - INBETWEEN. Innovation Action. Abstract: IN|BETWEEN aims at delivering an innovative and interoperable platform to collect, process and manage data coming from different sectors combining them into a coherent, comprehensive, multi-disciplinary methodology to boost the transition to a more resilient built environment at a district scale. To pursue this objective, IN|BETWEEN will provide cost-effective measures, tools and solutions for large-scale high-quality actions to achieve energy savings, improve quality of life and stimulate investments in the construction sector. Responding to the sectorial challenge of developing sustainable solutions for building refurbishment, IN|BETWEEN assumes the space in-between the buildings as the virtual and real environment where a multi-criteria and multi-perspective approach to refurbishment moves from the building scale to the district one.

PROPOSAL - H2020-SCC-01-2015 – Smart NExUS. Innovation Action. Abstract: European smart cities face the challenge of sustainable urban transformation from within their historic city fabric. Intelligent development of near-zero energy districts will succeed with tailored but replicable interventions that efficiently weave new energy and mobility systems into historic built environment, existing city infrastructure and local socio-economic use patterns. Smart Districts have to be designed in dynamic relation to overall energy and mobility flows of the city. Scaling smart urban systems will require integrated transformation strategies that balance decentralised energetic optimisation of smart buildings and districts with the systemic transformation of city and regional energy production and distribution networks and sustainable mobility systems. The Smart City Lighthouse projects Berlin, Paris and Bologna will strategically link a network of smart districts and neighbourhoods to scale district-level integration of sustainable mobility and energy to the urban dimension.

FUNDED PROJECT - H2020-SC5-21-2016-17 – ROCK. Innovation Action. Abstract: ROCK aims to develop an innovative, collaborative and circular systemic approach for regeneration and adaptive reuse of historic city centres. Implementing a repertoire of successful heritage-led regeneration initiatives, it will test the replicability of the spatial approach and of successful models addressing the specific needs of historic city centres. ROCK will transfer the Role Models blueprint to the Replicators, adopting a cross-disciplinary mentoring process and defining common protocols and implementation guidelines. ROCK will deliver new ways to access and experience Cultural Heritage [CH] ensuring environmental sound solutions, city branding, bottom-up participation via living labs, while increasing liveability and safety in the involved areas. ICT sensors and tools will support the concrete application of the ROCK principles and the interoperable platform will enable new ways to collect and exchange data to facilitate networking and synergies. The added value is the combination of sustainable models, integrated management plans and associated funding mechanisms based on successful financial schemes and promoting the creation of industry-driven stakeholders' ecosystems. A monitoring tool is set up from the beginning, running during two additional years after the project lifetime.

PROPOSAL for the city of Bologna – 100 RESILIENT CITIES – Rockfeller Foundation

Organizzazione mostre:

Elisa, Bottan; Saveria Olga Murielle, Boulanger; Tomaso, Lanteri Minet; Chiara, Mariotti; Alessia, Zampini, RIUSO. 16 proposte per la città - Festa dell'Architettura 2014, 2014. [mostra o esposizione]

Acknowledgments

Un grande ringraziamento alla mia famiglia e, in particolar modo, a mia madre per il supporto di questi ultimi tre anni e di tutti gli anni della scuola e dell'università. Grazie per credere in me e nella strada che ho scelto, per avermi insegnato l'educazione e l'amore per i libri. Grazie a Gisella perché è per me un modello di vita accademica.

Un grazie particolare a Daniele per il suo supporto quotidiano, per avermi sopportato in questi tre anni di duro lavoro, per condividere quotidianamente con me le difficoltà del mondo della ricerca, per l'amore costante che mi dimostra e per capire i miei sforzi nel percorrere la strada della carriera accademica.

Desidero ringraziare il Prof. Andrea Boeri, tutor e supervisore della ricerca, per tutti i consigli e le revisioni, per avermi sempre coinvolta nelle attività del gruppo di ricerca e per avermi assecondata nella scelta del tema. Un ringraziamento particolare alla Prof.ssa Danila Longo, co-tutor della ricerca, per tutte le correzioni, le interessanti discussioni e per il supporto accademico e morale di questi anni. Grazie all'Ing. Giovanni Fini, co-tutor esterno della ricerca, per i consigli e per l'esperienza di tirocinio all'interno del Comune di Bologna.

Questo lavoro non sarebbe stato possibile senza il gruppo di ricerca in Tecnologia del Dipartimento di Architettura dell'Università di Bologna e, in particolar modo, ringrazio di cuore il Prof. Ernesto Antonini per le interessanti discussioni sul tema della città e per tutti i consigli metodologici e il Prof. Jacopo Gaspari per aver sempre letto con interesse il mio lavoro. Grazie a Valentina Grianfrate per il supporto scientifico e morale. Siete per me un grande modello da seguire.

Un ringraziamento particolare a Marco Marcatili di Nomisma per i pomeriggi passati a discutere del mio lavoro, per le interviste e per aver indirizzato le mie riflessioni sul tema della rigenerazione urbana. Grazie a Daniele Ara del quartiere Navile per avermi fornito un valido punto di vista nello studio del quartiere. Grazie allo staff Climate KIC Italia.

Un ringraziamento speciale ad Antonietta Messina per aver letto e riletto la tesi e per avermi corretto inglese e non solo, per tutti gli "in which" e le didascalie.

Grazie a tutte le persone che hanno fatto parte della mia vita in questi tre anni e che in modi diversi hanno saputo aiutarmi nel mio lavoro: Debora, Riccardo, Antonietta.

In ultimo, ma non per importanza, grazie a Nanja per essere diventata un'amica speciale e una valida collaboratrice nella stesura di articoli scientifici.