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Eleonora Riva Sanseverino
Raffaella Riva Sanseverino
Valentina Vaccaro *Editors*

Smart Cities Atlas

Western and Eastern Intelligent Communities

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Editors
Eleonora Riva Sanseverino
University of Palermo
Palermo
Italy

Valentina Vaccaro
University of Palermo
Palermo
Italy

Raffaella Riva Sanseverino
University of Palermo
Palermo
Italy

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Preface

Smart is nowadays an exceeded and abused term. Beyond measure used to characterize almost every object of our daily lives, it is above all decidedly not appropriate to define a community. Time has clearly shown that urban communities have too many connotations to be compared on the basis of common smartness indicators. Indicators that little or do not at all address the context of situations and the great phenomena of our times. The word must then take on different meanings according to the context and timing. The experiment Favara Farm Cultural Park in the heart of Sicily on the edge of Europe is not, nor will ever be, mentioned in the smart cities rankings, but offers an attractive and inclusive development model, as stated in the Web site http://www.farmculturalpark.com/ «a small community committed to invent new ways of thinking and living» and again, «a place that makes you happy». Culture, therefore, as a tool to initiate communication between very different people, a tool to fight extremism and violence.

Moreover, the recent history and many prominent personalities of our time bring back strongly to the theme of the themes in the cities: the man and the care for "our common home."[1] The enthusiasm for technological innovations, to which we feel accustomed to, goes to the background: increasing bandwidth availability for richer and faster communications, sensors immersed in the asphalt and control of lighting to ensure increased energy efficiency, management of systems for the accumulation of energy or for charging electric vehicles, photovoltaic panels with any possible mechanical property, etc.

Considering that in the big cities over 80 % of the world gross domestic product (GDP) is generated and that between 60 and 80 % of energy consumption, resulting in emissions of pollutants into the atmosphere, takes place in the cities, the wisest countries try to make cities places that are resilient and flexible, comfortable and safe: resilience to climate change then, but above all, attractiveness and social inclusion. And while European cities are becoming empty of young people, cities of the Middle East and the Far East are growing disproportionately today,

[1]Encyclical letter "Laudato si'" by Pope Francis, 2015.

converting the growth of population in growth of income per capita: Fuzhou in China has a population of over 6 million inhabitants, with a yearly growth of employment rate of 2.7 % and GDP per capita growth of 8.0 %; Ankara in Turkey has nearly 5 million people, a yearly increase of employment rate of 5.7 % and a yearly growth of GDP per capita of 1.1 %; and finally, Dubai, in the United Arab Emirates, has a population of over 3 million inhabitants, an employment growth rate of 4.7 % and a GDP per capita growth of 4.5 %.[2]

According to a forecast from Oxford Economics Company, in 2030,[3] the demographic crisis will also invest several cities of the Far East and will see the world's population growth driven by Africa. On closer inspection, however, this growth of urbanization and of economic indicators appears to be inadequate to the times we live in, if it is true that among the 50 cities in the world, selected in 2015 by the consulting company Arcadis, as "representative" of development models, Dubai is also among the less sustainable cities.[4] To understand what the future of cities will be, it can be useful to refer precisely to the current community development models.

In general, we can identify two successful approaches in engaging with political structures and communities to address global problems. One of these is the approach proposed by the American economist Jeremy Rifkin (the so-called third industrial revolution, which was endorsed by the European Parliament in 2007) focused on how to influence governments to make a transition to a low-carbon economy. On the other side, there is the Hopkins' approach[5] addressed to communities and individuals with the aim of initiating a social innovation process, which will lead to a more sustainable way of living.

Rifkin's vision includes five pillars that will reduce carbon emissions from energy generation and use: renewable energy, buildings that contribute to energy generation from renewables, energy storage, ICT[6]-based energy distribution systems, and electric vehicles.[7]

Hopkins instead focuses the attention on communities and bottom-up actions. These can be the tools to address global problems and meet local needs such as local generation of energy and food production, different organization of health

[2]"The World's 10 Fastest Growing Metropolitan Areas" by Joseph Parilla and Jesus Leal Trujillo, 2015.

[3]"Future trends and market opportunities in the world's largest 750 cities," Oxford Economics, 2013.

[4]The sustainability index comes from the combination of economic, social, and environmental indices.

[5]An independent British activist.

[6]Information and communication technologies.

[7]Rifkin has also explored how the "Internet of Things" and "collaborative commons" might lead to a more democratic organization of social and economic life. The Internet of Things serves as an enabler in this process of change by continually feeding "Big Data" in real time to all potential users to support better informed and timely decision making. Source: http://www.scl.org/site.aspx?i=ed43114.

care, use of local building materials, reduction and reuse of waste, and other activities that communities might initiate according to their social, economic, and environmental context.[8]

On the basis of these concepts, we, macroscopically, can identify three types of communities, in relation to different levels of technological innovation and human presence as a key factor in the achievement of energy savings targets, social inclusion, and economic development.

"Transition towns" are the first type of smart communities. This model was proposed in 2005 based on the ideas of Hopkins.[9] Transition towns are founded on sustainable negative growth, know-how exchange, and the concept of community, these are cities where the "human" factor is preeminent.

The cities with strong prehistorical existence, like many European cities, can be considered a second type of smart communities. These cities show features like limited possibility to apply technology, but still have an adequate level of development to understand and correctly implement the ICT-driven choices.

Finally, the newly built and highly technological cities, like Masdar city in the United Arab Emirates, where everything has been planned from scratch on white paper to limit emissions and increase the quality of life of citizens.

The theme of social inclusion, so essential in the Transition Towns to ensure the survival, can become a tinsel in the technological cities.

Looking ahead and thinking about the future of cities means to make it possible, thanks to technology, the integration between people and the emergence of a *collective intelligence* by exploiting the huge hidden wealth in each individual. The technology in the cities of the future will therefore have an important role as a tool for enabling a true sharing of ideas, recognizing that innovation is generated on the border of disciplines and diversity. The city of the future will necessarily become more equitable and inclusive. From a technological point of view, I guess that they will integrate renewables and thus will show infrastructures for flexible and climate-resilient urban services. The networks of municipal services will be split at district level with local reserves to ensure supply in case of events that could compromise the main distribution network. The size of the district is indeed the one that allows the implementation of forms of energy balance and at the same time the provision of high-quality services. It allows the use of heat and electricity generation systems with higher average efficiency than that of smaller systems (in the case, for example, of cogeneration plants). In addition, the aggregation of citizens in districts could allow forms of purchase of goods and services in a shared manner as it already happens in Freiburg and other Northern European countries with cars shared among several families. Opel and Ford have recently proposed commercial

[8]Hopkins' book has inspired the establishment of community groups known as Transition Towns worldwide. Source: http://www.scl.org/site.aspx?i=ed43114.

[9]Hopkins, R. (2008). The transition handbook. *From Oil Dependency to Local Resilience, Cambridge*.

offers to share car use among multiple users with packages including different people that share the costs of purchasing, maintenance, fuel, etc.

The development of new architectures for the operation of urban functions passes through the development of enabling technologies and the reduction of the associated costs. As an example, the most common electric energy storage systems, the lithium-ion batteries, still do not hold sustainability, technical efficiency, and economic feasibility that appear fully satisfactory.

The transition of cities to a district model needs a full rethinking of territorial governance. The cities will be pervaded by efficient sensors that through the Internet of Things (IoT) technology will be able to collect and transmit environmental signals. Recently, the commercialization of ultra-low power sensors (autonomy of 10 years), low bit-rate (LoRa technology), and high range (up to 15 km) with the capacity to cross walls and asphalt layers let us perceive new scenarios. Promising for the monitoring of the values of relevant features sensed in the city's infrastructures (the water flow/pressure in the pipes and the temperature of underground lines), these sensors will enable the integrated management of the networks of services, increasing their reliability.

Logistic and technology solutions that enable humans to live better or, rather, to survive. And in fact no doubt that in the absence of containment of emissions and a radical change of behavior of each of us, what is now considered unnecessary will become necessary. Anyone will need to share, anyone will need to communicate, giving up something that today is considered essential.

The measures implemented by the Municipal Administrations today in Amsterdam and Stockholm, among the most virtuous European cities in the energy field, with a forecast, by the municipality of Amsterdam, of coverage of private consumption of electricity from renewable sources up to 50 % by 2040, while the municipality of Stockholm provides a totally green coverage of thermal and electrical needs by 2050. Thanks to the upgrading of the national electricity generation plants; in fact, the use of electricity taken from the public distribution of energy could be less polluting than installing systems for distributed generation. These environmental assessments guide new strategies for Stockholm that together with the other Scandinavian countries aim to eliminate fossil fuels, focusing on district heating with biofuels derived from municipal waste.

In terms of inclusion, European cities, today digging ditches and raising walls and protections against invasions of migrants' children, will need to accommodate them to lower the average age and create workforce. Then, it will be necessary to think about how to host these people without creating enormous ghettos or suburbs, ensuring their access to education, clean water, mobility, and energy in a sustainable way. European cities will then have to rethink the networks of urban services. Self-sufficiency in energy districts as well as a cheap provision of different resources will be needed.

Interoperable smart and inclusive management of urban services will also be a need, in order to turn these people into a resource for our city and not a problem to solve.

Social inclusion and the promotion of spaces to foster collective intelligence experiments, today accessory theme for city governments, will be necessary to prevent wars and poverty.

Ultimately, connectivity is common denominator of all smart community experiments. The possibility of using the field data collected for different purposes, from governance to crime control (Blue Crush in Memphis, USA), the mobility management and the online buying and selling of energy (i.e., Amsterdam).

And finally, here is another keyword emerging: Big Data, a term which transfers the information size that can and should be managed by powerful data analysts who can already and will increasingly derive meaningful indicators to guide the rulers and citizens choices. Yes, even the rulers, because the cities in which we live and in which we will live, will be increasingly driven by politicians whose actions will be data driven, that is, informed.

Cyber smart cities administrations will transform from providers of telematics services to platform providers, whose efficiency can be measured by the ability to balance data security and data openness. I imagine agile systems of rules that can protect citizens while ensuring the opportunity for all to access data to develop applications in order to provide additional services to the community.[10]

Finally, thanks to a complex sensing and control system, Alphabet (under the Google umbrella brand) promises in short time a car that will drive alone with GPS on board. What will our cities become with cars that are capable of getting about independently? How is the traffic going to change? What is certain is that the city and the citizens who will not be able to adapt will find an increasing competitive gap that will soon be unbridgeable. Will this create increasing exclusion and marginalization?

The book is arranged in three parts. The first one is a review of recent European policies on the issue of smart cities, the second comprises a smart cities atlas showing some relevant examples in the world. The third part proposes some critical views about the smart cities issue with a focus on humans. The aim of this section is to show what are some of the basic modern ingredients of the smart city (technology, sharing economy, regeneration of urban spaces for cultural initiatives, etc.) and what are the risks associated to such model of urban development combining these ingredients. What the authors' envision, if such ingredients are not wisely combined, is essentially the threat of a *selective joining* to smart communities having given productivity and economic targets that appear miles away from those that are necessary to build an intelligent community.

[10]"Smart rules for smart cities," Springer for Innovation, E. Riva Sanseverino et al., Ed. Springer, 2014.

It is not by chance that recently a strong invitation from Eastern and Western religions comes to the governments to educate citizens of different countries to a global citizenship. The aim is to unveil the consciousness of the unlimited possibilities and of the importance that each single life owns.

Palermo, Italy

Eleonora Riva Sanseverino
Raffaella Riva Sanseverino
Valentina Vaccaro

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Part I
Smart City: Definitions, Policies, Tools

What we need are cities that reflect a different new urbanism, a new urbanism that is dramatically more ecological in design and functioning, that has ecological limits at his core.

T. Beatley, *Green Urbanism—Learning from European cities*, Press Island 2000

Chapter 1
General Overview

Eleonora Riva Sanseverino, Raffaella Riva Sanseverino and Valentina Vaccaro

Abstract The chapter introduces to smart city issue through a historical excursus, which traces the main steps: the birth of global environmental policies up to the stage of maturity reached in Europe after the Kyoto Protocol (1997); then the Climate Package 20-20-20, edited by European Commission in 2008 marks another crucial point which preludes smart cities initiatives and projects; the 2030 Energy Strategy and finally the 2050 European Energy Strategy. The chapter is concluded with a review of the most popular smart cities ranking systems and with a proposal for a ranking based on context features.

1.1 Global Environmental Policies

From the seventies onwards the environmental issue has became a key factor for developed countries: it is a general understanding that all the development models must be balanced and revised to preserve the quality of the natural heritage also accounting for the limited resources of our planet [1].

In June 1972 in Stockholm[1] took place the Conference of the UN for the Human Environment, which involved world governments on environmental issues and development policies. It was recognized that the transformation ability of human

[1]The UN General Assembly convened the United Nations Conference on the Human Environment which was held in Stockholm City from June 5th to June 15th 1972.

E. Riva Sanseverino (✉) · V. Vaccaro
Dipartimento di Energia, Ingegneria dell'informazione e Modelli matematici (DEIM), University of Palermo, Palermo, Italy
e-mail: eleonora.rivasanseverino@unipa.it

V. Vaccaro
e-mail: valentina.vaccaro.pa@gmail.com

R. Riva Sanseverino
SmartplanningLab, University of Palermo, Palermo, Italy
e-mail: raffaellarivasanseverino@gmail.com

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beings, if properly applied, can bring well-being and improve the quality of life, but otherwise it can create environmental damage, destruction and loss of resources. In the eighties it is more and more necessary to reconnect economic growth and equitable distribution of resources in a new development model. The organizing principle of this paradigm is found in the concept of "sustainable development": a set of values that involves all fields of human activity, in a cross-related and long term perspective.

In 1980 the United Nations Environment Programme (UNEP) and WWF drafted the document "World Conservation Strategy of the Living Natural Resources for a Sustainable Development" according to which to meet the challenges of a rapidly globalizing world, a coherent and coordinated environmental policy must go hand in hand with economic development and social commitment. The objectives set out in the document were summarized as follows: maintenance of vital systems and essential ecological processes, conservation of genetic diversity and sustainable use of species and ecosystems.

A few years later, more precisely in 1983, the Organisation of the United Nations (UN) set up the World Commission on the Environment and Development, headed by Gro Harlem Brundtland [2]. From the awareness of aiming at action-oriented environmental management of the territory and human activities, in 1987 it came to life the concept of "sustainability" and "sustainable development" with the publication of the Brundtland Commission's Report on environment and development called "Our common future". This assay specifies how the world is facing a global challenge that can only be faced by taking a new model of development called "Sustainable", i.e. "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Another cornerstone of sustainable development is represented by the United Nations Conference held in Rio de Janeiro[2] in 1992. The Rio Declaration on Environment and Development states the 27 Principles on Environment and Development, the Principles of Forests and the Agenda 21, that are still alive and present.

Sustainable development [3–6] takes, therefore, the characteristics of an integrated concept, arrogating to itself the need to combine the three fundamental and inseparable dimensions of environment, economy and society, given that it is evident how the environmental action alone cannot meet the challenge: any policy or plan of action, infact, must be in the frame of an integrated vision and must define its economic, social and environmental impacts. Sustainable technological progress arises then as a necessary tool to achieve the goal of a judicious use of natural resources, reducing the consumption of non-renewable resources, limiting the production of waste and the substitution of natural heritage (land, material resources, living species) with built heritage (transformed natural resources).

[2]The world summit, held in Rio de Janeiro from June 3rd to June 14th 1992, was the first world conference of the states governors on environment.

Agenda 21,[3] in which it is "recognized that working towards sustainable development is the main responsibility of governments and requires strategies, policies, plans at national level", is the program of action indicated by the Rio conference to reverse the negative impact of human activities on the environment. The Agenda [7, 8] defines indeed the activities to be undertaken, the subjects to be involved and the resources to be used in relation to the three dimensions of sustainable development (environment, economy, society), making it a complex process given the different nature of the problems faced and the inevitable references to different scales of government interventions. The environmental problems [4, 5] are indeed both on a global scale, in which effects of global concern can be appreciated, as well as on a local dimension, characterized by specific phenomena, linked to the local environment and territorial activities. The United Nations Framework Convention on Climate Change of 1994, signed in Rio by 154 countries, plus the European Union, which came into force on March 21st 1994, is another essential factor for the development of global policies to fight climate change. It was based largely on the conclusions reached by the World Meteorological Organization reports, the IPCC[4] and sets a goal of stabilizing concentrations of greenhouse gases to protect the climate system, and to achieve it, promotes actions at national and international levels. It provides only a commitment on the whole for industrialized countries to bring by 2000 the greenhouse gas emissions to the 1990 levels.

Signed in December 1997, the Kyoto Protocol[5] indicated the international objectives for the reduction of the emissions of the six green-house gases responsible of the global warming that could lead to serious climate changes [9]. It represents an important step forward in the fight against the global warming, because it contains constraining and quantifiable objectives for the limitation or reduction of green-house gases emissions [10]. Globally, the countries included in annex I of the framework agreement, namely industrialized and developing countries, were collectively committed to reduce the green-house gas emissions [9] between 2008 and 2012 of at least 5 % as compared to the measured levels of 1990.

Finally, the global climate agreement reached during the 21st Conference of the Parties to the UN Framework Convention on Climate Change (UNFCCC COP21) aims to keep the overall increase in average temperature below 2 °C. The latter is now the main objective of the European Union.

[3]Agenda 21 is a wide and diversified set of actions, derived from the ONU Conference on Environment and Development of Rio in 1992, and can be considered as a sustainable development manual for the planet.

[4]The Intergovernmental Panel on Climate Change, IPCC, is the scientific forum made of the two UN organizations, the World Metrological Organization, WMO, and the UN Environment Programme, UNEP, to study the global warming effect.

[5]The Kyoto Protocol is an international treaty on the environment concerning the global warming phenomenon and undersigned in the Japanese city of Kyoto on December 11th 1997 from more than 160 countries in occasion of the COP3 framework conference of United Nations on climate changes (UNFCCC).

1.2 European Environmental Policies

In January 2008 the European Commission presented an integrated proposal which addresses the problems of energy supply, climate change and industrial development: the Climate Package 20-20-20 [11, 12]. The package includes a set of directives summarizing the objectives that the European Union aims to achieve by 2020:

- reach a 20 % reduction of green-house gas emissions of the EU member states;
- increase the share of energy produced from renewable sources to 20 %;
- achieve savings in energy consumption by 20 %.

Since 2014, the Juncker Commission has outlined the main 10 priorities. Among these, the one on 'Energy and climate Union' aims at a competitive, environmentally sustainable and safe economy; it is thus laid the groundwork for a common approach on energy (State of the Energy Union). The main areas of focus are: reduction of emissions, energy efficiency, a fully integrated energy market, security of supply through coordinate use of infrastructures, integration and diversification of energy sources along with the support of production, efficient consumption of energy, research and technological innovation. Price liberalization and the use of smart technologies for demand management will also start a process of containment and control of energy consumption also to improve the security of energy supply, both in the form of fossil fuels and of electricity. Besides, in addition to the security of supply of electricity, also the security of gas supply is a crucial element. The EU is the largest importer of gas in world and gas can play a crucial role in assisting the EU's transition to a low-carbon energy system since it can be considered a back-up fuel for renewable energy, when weather conditions prevent the production of energy from renewable sources. Finally, the interconnection between energy systems and the ability to store energy will allow flexibility and security in energy supply.

Figure 1.1 shows the European objectives for 2020–2030 and 2050.

Among the tools that will be used to achieve emissions reduction, there are the changes to the European Emissions Trading System (EU ETS).[6]

With the new package, carbon dioxide will no longer be the only green-house gas under observation: limits are also posed to nitrous oxide (N_2O) and perfluorocarbons (PFCs). Three sectors are instead affected by the use of renewable energies: electricity, heating and cooling and transports.

On the side of sustainable development of the community, the Covenant of Mayors[7] [13], an initiative promoted by the European Commission, aims to actively

[6]The European Union Emissions Trading Scheme—EU ETS is the main action adopted at European Union level, to implement the Kyoto Protocol, to reduce gree-house gas emissions in the energivorous sectors, namely the industrial sectors characterized by the largest emissions.

[7]Heralded as the "world's biggest urban climate and energy initiative" by Commissioner Miguel Arias Cañete, the Covenant of Mayors for Climate & Energy brings together thousands of local and regional authorities voluntarily committed to implementing EU climate and energy objectives on their territory. New signatories now pledge to reduce CO_2 emissions by at least 40 % by 2030 and to adopt an integrated approach to tackling mitigation and adaptation to climate change.

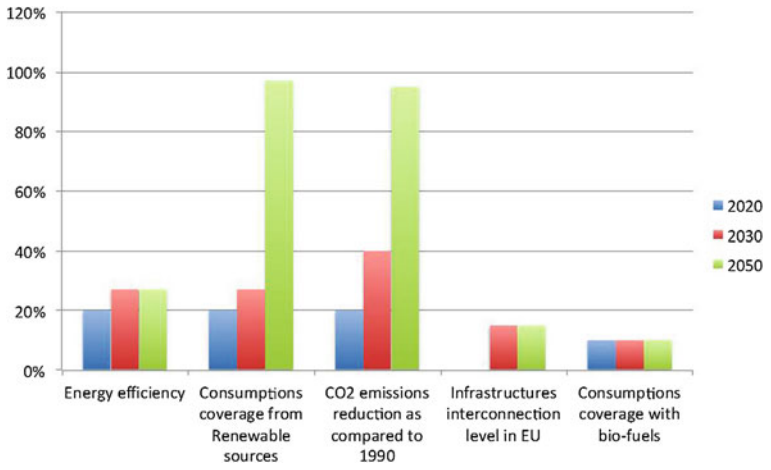

Fig. 1.1 European objectives at 2020, 2030 and 2050

involve European cities in the development of a strategy towards energy and environmental sustainability. The initiative was launched by the Commission on January 29th, 2008, in the second edition of the EU Sustainable Energy Week [14].

The pact, to date, was joined by more than 6000 cities including over 50 major European cities and many cities of non-EU countries, with a mobilization of nearly 200 million people. It provides the local administrations an opportunity to engage in a concrete way in the fight against climate change through measures that modernize the administration and directly affect the quality of life of citizens.

Signatories represent cities of various sizes, from small villages to major metropolitan areas. The clean mobility, energy upgrading of public and private buildings and public awareness regarding energy consumption are the main areas on which the interventions of the signatory cities are focused.

With these actions, local governments undertake to contribute to reducing emissions of harmful green-house gases by 20 % by 2020, as required by the European Union 20-20-20 strategy. The Covenant of Mayors is also an opportunity for growth for the local economy, helping to create new jobs and acting as a driving force for the development of the green economy[8] in its territory.

The aim of the pact is to help local governments to take a leading role in the implementation of policies on sustainable energy. The municipalities that sign the Covenant of Mayors commit to submit their "Action Plan for Sustainable Energy", namely the tool that reports concrete policy measures to be implemented to achieve the posed objectives. The Plan is a key document designed to demonstrate how the council intends to achieve the targets for reducing carbon dioxide emissions by 2020.

[8]*Green economy* is a theoretical model of economic development.

That the Covenant of Mayors is a major step for the attainment of the objectives of the Climate Package is demonstrated by the fact that cities consume 70 % of the energy needed by entire EU.

On this enormous energy-saving potential of cities, the European institutions leverage to reduce the emissions by 20 % by 2020 and at the same time develop a low carbon economy by 2050.

The formula identified associates the more rational use of resources to the integration of clean technologies. Europe therefore encourages smart communities that go towards integrated and sustainable solutions providing energy at affordable prices and reliably to citizens, reduce consumption and create new markets in Europe and elsewhere.

The EU[9] refers the term "smart", in particular, to those cities that are able to positively affect urban quality parameters according to an assessment based on economic, social, cultural, environmental, housing and management. The *Smart Cities* project is part of the more comprehensive and ambitious European program.

The Smart Cities project is part of the Strategic Energy Technology entitled "Investing in the development of low-carbon technologies" or more commonly known as SET-Plan (Strategic Energy Technologies for Long Term), under which the European Union will create a network of thirty smart cities to be selected by 2020. A sort of prototype model of energy efficiency to be started to a path of economic and urban development at low costs and reduced environmental impact.

The first call Smart Cities under the Seventh Framework Programme was about 70–80 million for renovation projects of public and private buildings and energy networks.

Horizon 2020 [15] provides today and in the coming months, in the first Work program "Secure, Clean and Efficient Energy", a number of calls in the area Smart Cities and Communities.

The development of urban areas is in fact an important challenge. It requires new efficient and user-friendly technologies and services in the areas of energy, transport and ICT. However, these solutions require integrated approaches both in terms of research and of development of technological solutions of high commercial impact.

In addition to initiatives for sustainable development of the city starting from the EU, there are others that have their origins in the European city governments. Founded in 1986, Eurocities [16] is the network that brings together the local governments of more than 130 large cities in about 34 European countries. Eurocities represents the interests of its members and engages in dialogue with the European institutions across a wide range of policy areas affecting cities.

Among the topics of interest can be found: economic development, environment, transport and mobility, social affairs, culture, information society and knowledge, as well as services of general interest.

[9]The platform *Smart Cities* launched by the European Union involves many aspects of urban decision making: the scientific research for innovative management of the urban mechanism plays a key role.

The statement Eurocities on Climate Change reiterates that the local level has an essential role in the fight against climate change and therefore cities are crucial partners, in coordination with the EU institutions and the Member States. The declaration reflects the commitment of Eurocities to fight against climate change.

The member cities have carried out a number of considerations that have as their ultimate goal the protection of the environment, starting from the conditions that emerged from the World Meteorological Organization reports, Intergovermental Panel on Climate Change, IPCC, implementing strategies to combat climate change.

There are many common points between the commitment of Eurocities and the United Nations Declaration [17] on Climate Change of 1992:

- adapting global objectives, defined by the international community of scientific negotiation, at territorial level, through a combination of joint efforts;
- implementing a climate plan in each of the territories, based on concrete actions, in order to reach a local objective that is consistent with European and international objectives. The creation of this climate plan must begin with an audit of the emissions in the territory, including the assessment of the weak points, in order to allow a compensation in time;
- regular measurement and drawing up reports about reductions in greenhouse gas emissions in order to assess the efficiency of the actions in the climate plan, using truthful and reliable methods.

The cities belonging to the network are also committed to involve all the actors on the territory following different modes.

- With targeted actions, starting with citizens, in an organized and coherent way, to respond collectively to the challenge posed by global warming and promoting and supporting private and public initiatives for climate protection.
- With the development of innovative partnerships in the fields of research and higher education.
- Informing and increasing the awareness of the public in an atmosphere of shared responsibility between individuals and society, in order to promote an ecological behavior to reduce green-house gas emission. The dissemination of scientific knowledge on global warming is a key element in increasing public awareness.
- By focusing on the priorities of disadvantaged sectors of society, following the principles of sustainable development, recognizing that natural resources, and particularly energy, are limited.
- By improving the performance in public services and reducing their carbon emissions, investigating the possibility of using technological innovations.
- Adopting ambitious sustainable energy supply policies in the public sector, which play an essential role in the actions against climate change, both as a positive example for citizens to create an economic demand in the productive sectors that provide technological solutions.

To achieve all these objectives, it is required to work on urban planning and the quality of our cities.

- Limiting urban *sprawl*[10] and developing compact cities, which reduce space requirements and energy and in which the collective way of life constitute a growth factor. Urban *sprawl* is the building of new areas. This is seen as an "absolute evil" as it devours agricultural and natural spaces, gives rise to additional transportation requirements and therefore is an important factor in the increase in green-house gases. Its limitation is a primary aspect of urban policy. Compact cities reach the dual objective of urban quality and quality of life, meaning maintaining sufficient green spaces.
- By creating new "ecological districts", where the density of population, social integration and cultural and economic diversity represent fundamental values; and in which are implemented technological innovations in the transport, waste management and water.
- Building energy-efficient buildings, and promoting eco-building in territories, with high standards of thermal efficiency and using environmentally friendly materials. The green buildings must become a standard for all construction work, both for the new construction as well as for the restoration.
- Supporting the sustainable recovery of existing buildings: considering the high contribution to the production of green-house gas emissions of buildings, this commitment is a primary challenge in the fight against global warming.
- Ensuring the preservation and development of urban green, in public and private gardens, and in new peri-urban forest areas on the outskirts of urban areas. New planting schemes will respect landscapes and specific territorial biodiversity.
- Working on transport and urban mobility:

  a. Supporting public transport and types of soft mobility (walking and cycling) with a reduction in polluting emissions and less dependence on fossil fuels. To allow this, it is required to provide alternative and high quality transportation services for people and goods while respecting the environment;
  b. Connecting territories and linking the public transport networks in order to ensure the most favorable conditions for the movement of people and goods; inventing new types of mobility management regulations of streets mobility in cities;
  c. Encouraging technological innovation for mobility and the use of new forms of energy for transportation. The creation of specialized research centers will also be facilitated.

[10]Urban sprawl or suburban sprawl describes the expansion of human populations away from central urban areas into low-density, monofunctional and usually car-dependent communities, in a process called suburbanization. In addition to describing a particular form of urbanization, the term also relates to the social and environmental consequences associated with this development.

- Supporting and developing the use of information and communication technology for citizens, such as the Internet, video conferencing, etc., which can help reduce unnecessary trips and, consequently, emissions.

Essential, finally, to achieve the goals is to work on renewable energy by diversifying energy production by implementing a number of measures needed in a gradual climate change.

In particular actions such as:

1. The development of renewable energy production that would result in exceeding the current objectives of the European Commission and support the development of technical innovations for the use of renewable energy to improve energy efficiency and marketing;
2. Adapting the production of heat and electricity to the geography of the territories; reducing the energy consumption of urban systems (transportation, buildings, energy networks, water networks);
3. Reduction of waste at source, through recycling and recovering energy from non-recyclable waste (heat, biogas, etc.).

Also in Italy[11] many initiatives have been launched since 2012: in particular, in the context of experimental research, the eight[12] winning projects of the call Smart Cities and Communities dedicated to the regions of Southern Italy assigned by the Ministry of Education, Universities and Research [18] of about 200 million euro.

The research projects are studying innovative solutions for sustainable mobility, health, education, data management in public administration, renewable energy, culture and tourism, energy efficiency and natural resource management.

1.3 About the Classification of Smart Cities and Smartness Indicators

European policies are thus well aware of the crucial importance of cities in the development of states and territories. However, the context aspects, the socio-cultural and legal aspects, the needs of citizens are still, in many countries and for different urban contexts, not well addresses. EU policies and some particular

[11]On October 30th, 2012 the "Smart Cities Exhibition 2012" was held in Bologna. It was directed by Jarmo Eskelinen, leader of Living Labs, and Mario Calderini, adviser to the Minister for Research, the University and the Public Education, coordinator of the working Group on Smart cities and Communities cockpit Director for Digital Agenda Italian. The event was repeated every since that time.

[12]The eight selected projects are: Smart Healt and Cluster Osdh, Smart Fse Staywell, Prisma, Dicet-Inmoto and Orchestra, Edoc@Work 3.0, Aquasystem, Be&Save, Siglod, Res Novae, Sinergreen and Sem Smart Energy Master, I-Next and Smart Tunnel.

cross-border actions try to address these 'contextual' aspects, but still in many EU policies and documents it seems to be missing.

Nonetheless, in many countries like Italy, more than one third of the projects on Smart Cities are using funds from the European Union (such as Horizon 2020, LiFe +) or calls issued at national level (such as projects issued by the Ministry of Education in 2013 for "Smart cities and communities" or regional calls on ERDF—European regional Development Fund).

The reduced public resources mainly coming from EU are, in some countries like Italy, the primary means to activate Smart City initiatives.

The point is that in some countries *investments* are simply considered *costs* since traditionally in the past many actions have been addressed without a suitable attention to the contextual aspects and without any specified and measurable target. For the definition of actions with a remarkable economic impact, it is interesting to analyze the results of the study conducted by the Observatory on the Internet of Things[13] at the Polytechnical University of Milan [19]. In the analysis, they introduce the concept of Smart Urban Infrastructure (SUI) and they demonstrate that the creation of a SUI to provide three essential services (gas smart metering, smart lighting, waste collection) to a medium-sized city allows, compared to a not coordinated management of these services, a saving of 25–50 % of the investment costs and 50–70 % of operating costs.

Still on the subject of financing instruments for investment initiatives for redevelopment of cities in a smart perspective, it is to be noted that differently from Italy, in Europe but also in Asia, it is made extensive use of Public–Private Partnership as a pillar on which to base any projects implementation.

In Italy, for example, the use of these tools remains limited, especially for the difficulty to incorporate them into a specific regulatory framework, due to corruption phenomena or distrust from public authorities, in addition to the problem of finding forms of remuneration for privates, and for a general distrust of the *project financing* tool as the base of several public–private initiatives.

On this last point, in Italy, the "Committee for intelligent communities" established by the Agency for the Digital Italy (AGID) is developing a set of models of involvement and financial cooperation between public and private entities. These should more easily be able to be understood and explained to the public by the policy makers.

In addition to the financial aspect, then it is required to identify guidelines for the stakeholders and local authorities who wish to undertake a conversion path of their city into a smart city. The systematization of the reasoning about the city can certainly be helpful to understand how to create concrete tools to achieve the objectives that arise in terms of sustainability and integration of urban functions.

[13]Internet Of Things: global network infrastructure, dynamic and self-configuration capabilities based on standard communication protocols and interoperable, where the physical and virtual objects have an identity, physical attributes, virtual personality and use smart interfaces, as well as being perfectly integrated into the info-telematic network.

What steps must then be implemented in a given urban context to improve the level of smartness? How can be measured the smartness of a city [20, 21]? From the complexity that presents each individual urban context and its functions it is easy to understand that these measures will depend on several factors each variable on a completely different scale.

In literature there have been several attempts to measure urban smartness. The best known classification tools of the city are: the "Ranking of European medium-sized city" [22], "The Smart Cities Wheel" [23], "iCity Rate" [24] and "Smart City Index" [25].

The "Ranking of European medium-sized city" was the first developed ranking tool. The studies, conducted in 2007 by the Vienna University of Technology, in collaboration with the University of Ljubljana and Delft University of Technology, focus on medium-sized cities. Among the 1600 European cities, only a subset of 70 cities was analyzed, as they have some features that in the perception of researchers made them comparable: a population between 100,000 and 500,000 inhabitants, a users basin of less than 1.5 million people and the presence of at least one university. In the ranking carried out in 2008, in first place there was the city of Luxembourg. Along the 6 smart city dimensions (smart economy, smart people, smart governance, smart living, smart mobility and smart environment), the city of Luxembourg, in fact, showed indicators far above the average. Economy, in particular, was considered at an excellent level of smartness, since economic image, international embeddedness and productivity were quite above the average. Although people do not seem so creative, on the other hand Luxembourg showed a good ethnical mix and every citizen speaks at least a foreign language. Still now in the EU website 'Marketplace for of the European Innovation Partnership on Smart Cities and Communities, Luxembourg' commits itself towards sustainable urban mobility, Sustainable urban districts, integrated infrastructures, citizen focus and business models, finance and procurement. The basic actions are:

- electrification of public transport,
- multimodality,
- large scale (deep) refurbishment of city districts for energy efficiency,
- large scale deployment of zero energy new districts and zero energy new buildings,
- smart grid deployment,
- infrastructures monitoring and development of end-users designed services.

In 2012, the American magazine "Fast Company" published a study on the measurement of the level of smartness ("The Smart Cities Wheel"), of the European cities, led by urban and climate strategist Boyd Cohen. As ranked by Cohen, the smartest city in Europe was Copenhagen.

Other rankings have been developed at national level. In Italy, for example, a first attempt of measuring the smartness level of cities was conducted by the company FORUM PA [24], which proposed the "The ICity rate" index, which compares 106 Italian cities since 2012 on the basis of 150 indicators for 6 different

aspects: smart economy, smart people, smart environment, smart mobility, smart governance, smart living. Milan leads the Italian cities in 2015. What can be observed is that at the first places of the ranking in all the years a number of medium sized cities can be found. As commented by the researchers, they constitute the backbone of the Italian urban system. Southern and Northern Italy are strongly different with an increasing delay of southern cities with respect to the smart city initiatives.

Since several years, the company Between[14] first and then Enrst and Young have carried out a monitoring activity about the widespread of ICT (broadband platforms to digital services) in various Italian cities and created the "Smart City index", a ranking of all 116 Italian municipalities (identified by ISTAT[15]), based on three elements:

1. Evaluation of the technological infrastructure.
2. Ad hoc Investigations carried out by Between and use of data from institutional sources (ISTAT, Ministry of Education, etc.).
3. Analysis of a wide range of subject areas, from broadband infrastructure to digital services, up to indicators relating to the sustainable development of cities (sustainable mobility, renewable energies, energy efficiency and management of air, water and waste).

The ranking is based on the idea that the Smart City today has to have a different structure logistics based on four basic layers:

- basic infrastructure, enabling element for the construction of a smart logic of urban functions;
- a network of interoperable technological sensors, to collect big data and for the remote management;
- a delivery platform for the development and exploitation of big data of the territory;
- a series of applications and services that create added value for the city.

"Smart City Index" is a ranking that enhances digital services and rewards cities that through these structured interventions on the most diverse subject areas (Smart Culture and Travel, Urban Smart Security, Smart Justice) are some of these.

In this survey since some years, the city of Bologna firmly occupies first place followed in 2016 by Milan and Turin [25]. Also in this survey the large gap between northern and southern cities emerges as one of the remarkable aspects.

What emerges is that the Smart City requires resources, people and market that are more easily found in metropolitan areas penalizing small towns. The acceleration in the achievements with regard to innovation (ultra-wideband, open data,

[14]Leading Italian strategic and technological consultancy firm operating in the Information & Communication Technology (ICT), with particular focus on telecommunications.

[15]ISTAT: The Italian Statistical Institute, it is a public research institution. Present in the country since 1926, it is the main producer of official statistics in support of citizens and policy makers. It works independently and in continuous interaction with the academic and scientific world.

app), observed in the last year, has further widened the gap between the large and medium sized cities and small towns.

The centrality of Smart Planning in the European policy, was recently confirmed by the fundable sectors through the Structural Funds in the new 2014–2020 Program that allows public bodies to access the EU contributions in order to enhance institutional effectiveness, improve quality of public services and infrastructural projects.

In line with the need to use tools for assessing the smartness of the cities that can be shared and used by local governments, recently the International Organisation for Standardization (ISO) issued the ISO 37120: 2014 "Sustainable development of communities—Indicators for city services and quality of life" [26], the first international standard that identifies an integrated set of indicators for measuring the sustainable development of cities.

This standard is part of a new series of international standards being developed for a holistic and integrated approach to sustainable development and resilience of cities. Indicators provide a uniform approach as to what is measurable and that may pose an address parameter for administrators who want to develop a smart plan on cities. Compliance with this standard, however, does not confer a special qualification to cities, it provides an evaluation tool for development scenarios regarding the services of the city and the quality of life and their development in time. In fact the purpose of the indicators is to keep track and monitor progress on the performance of the city. The novelty compared to the previous analyzed ranking tools is that it materializes, through the norm, the holistic definition of the concept of smart city.

The assessment that the standard allows concerns the following areas: Economy (indicators assess the employment rate of citizens and the community's economic well-being); Education (indicators assess literacy and cultural level of the population); Energy (the indicators for evaluating access to energy services, its degree of sustainability as well as the average consumptions of the community); Environment (indicators related to the degree of environmental pollution of the urban environment); Finance (indicators relating to the productivity and growth of GDP); Emergency Response (indicators related to the measurement of urban resilience and response to natural disasters of any kind); Governance (corruption, citizen participation in local politics, gender mainstreaming in political processes are some of evaluable points); health (public health and longevity of citizens); Leisure areas; safety; waste (waste production and reuse); Transport and mobility infrastructure; Telecommunication services (broadband and access to telecommunications services); Urban planning (green spaces); Waste water (waste water collection and reuse); Dwellings (number of homeless and proportion of citizens living in barracks); Water (access to drinking water; water consumption and consistency of the urban water system).

The indicators were also classified according to a scale of importance. Indeed some indicators are identified as "essential", whose measure is needed for the overall assessment of the context and "side" indicators that give additional information and more specific clues on some issues. Another new feature of the standard

is to provide "profile indicators" that provide basic statistics and information (best practices) useful for cities that need some benchmark.

As clearly stated in ISO standard itself [26], this is applicable to any town, municipality or local government that is committed to assessing their performance in a comparable and verifiable way, regardless of size and location.

While it may be helpful to have a unique assessment tool that allows to compare, on the basis of shared parameters, the smartness of the world's cities, on the other, one wonders whether this is enough to help administrators in their role of "smart cities planners".

1.3.1 A New Proposal for the Ranking of Cities

As all the presented rankings make use of extensive and reliable databases, they take little account, or do not take at all into account, the pre-existing conditions, i.e. the local characteristics of geographical, but also cultural, political, economic and social issues which strongly influence the development of measures to promote urban smartness. These pre-existing characteristics, when not taken into account, lead to a ranking between urban contexts that are not comparable.

The work proposed here seeks to address these issues by identifying a methodology for the identification of "city models" or "benchmarks" to refer to thus facilitating the identification of actions to increase the smartness of the city. The methodology provides a way to look analytically the idea of the city.

Starting from the characterization of each city, which being a complex and unique system makes it difficult to identify some standardized smart urban planning actions, the methodology tries to represent the potential of urban context by using some parameters. The latter define the structure and the potential of the city in terms of infrastructures, energy and socio-economic characteristics. This characterization allows to identify similarities and differences between the potential of different urban contexts; in this way, it will be possible to classify urban areas with uniform characteristics and thus really comparable.

Some of the main characterization parameters of urban contexts are:

Geographical and climatological parameters

- latitude;
- altitude;
- monthly average solar radiation;
- main wind characteristics (i.e. average speed);
- presence of geothermal phenomena;
- proximity to the sea, lakes, rivers;
- topography (presence and abundance of reliefs).

The characterization of these parameters, allows to aggregate cities with the same potential with reference to natural resources. The available natural resources,

in fact, can be an important lever on which to center its sustainable development [27]. An emblematic case, as we shall see, is Amsterdam in which, thanks to the availability of large green areas and high winds on the outskirts of the town, the production of green energy from wind power is one of the strengths of smart development.

Urban and residential parameters

- population density;
- total area of the city;
- extension of the suburbs in relation to that of the town;
- extension of industrial zones in relation to that of the town;
- extension of the old town in relation to that of the town;
- prevailing building type;
- level of decentralization of public services;
- type of road infrastructure (channels/roads);
- incidence of road infrastructure in the historic center by type;
- incidence of road infrastructure in the industrial zone by type;
- incidence of road infrastructure in the expansion areas by type.

As emerges strongly from the latest report of the Directorate General for Internal Policies of the European Parliament [28], the smart cities paradigm mostly applies concretely to large cities. Respect to the six conventional ambits which define a smart city (smart governance; smart economy; smart mobility; smart environment; smart people; smart living), Fig. 1.2 shows that there is a clear correlation between city size and the number of smart city characteristics that the same city has. This because cities with a larger population have more resources (financial, political and human) and are able to carry a larger number of projects in many areas.

Environment, mobility and governance, remain, at a European level, the most addressed smart city issues. The size of the city is therefore a key element in order to detect the reference "benchmark".

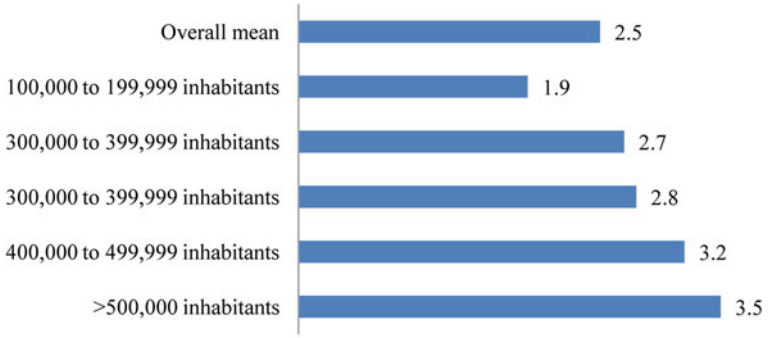

Fig. 1.2 Average number of Smart City issues addressed in relation to the average population of the city. Image processing from [28]

The extension and the population size also affect the infrastructure networks of a city and the mobility is one of these. The report [28] emphasizes that the highest percentage of public–private funding (which today constitutes one of the major resources of the smart city projects) is used in smart mobility measures and in redevelopment projects at neighbourhood scale.

The mix of fundings in this area has a balance in the achievements of the management systems and pilot projects for infrastructures, generally at the neighborhood scale, which usually involve a financial support from major funders (private and European), while the participatory governance platforms in general have modest funding requirements.

To identify the reference "benchmark" city, in the case of mobility, it is therefore essential to identify clusters of cities that have similar mobility flows and, as far as possible, have the same infrastructure network. As an example, the city of Amsterdam has developed its project of smart mobility with cycling and sea transport, but there is no doubt that its policy about mobility can not be a reference for those cities that, for urban extension and urban development, have focused their smart redevelopment about mobility on the use of private vehicles, such as is the case of the city of Singapore.

Another key element that is considered among the characterizing urban parameters is related to the buildings and their period of construction [29, 30]. The strongly historicized contexts, for example, are characterized by high domestic consumption and simultaneously by prestigious architectural features that restrict energy efficiency measures in the building. For the cities of art, for example, the reference "benchmark" can only be considered as a city of equal architectural value which carries out "soft" measures for energy improvement; in these cases we are quite far from the measures that are implemented in the newly developed cities such as Masdar City.

Economic and socio-cultural parameters

- citizens' average age;
- per capita income;
- level of education;
- level of raising on environmental issues, political orientation;
- prevailing economy type.

These parameters are used to measure the potential of citizens participation to smart initiatives proposed by the administration. In an educated context and traditionally attentive to welfare, initiatives that are based on the sharing and "strength of the group" may have the same impact as projects involving the construction of large infrastructures.

Infrastructure layers

- municipality position compared to the national energy infrastructure (peripheral/central);
- structure and characterization of the electrical network;

- structure and characterization of the wi-fi network;
- structure and characterization of the district heating-cooling network;
- structure and characterization of the water supply network;
- structure and characterization of the gas network.

As for mobility, urban infrastructures create service networks on which the projects must be developed. The characterization of these networks allows defining the possible actions of the smart city issues to be addressed. The identification of the "benchmark" cities must necessarily take account of those characteristics. The city of Amsterdam, for example, to reduce thermal energy consumption by autonomous systems powered by fossil fuels at home, is implementing the extension of the district heating network. Such action of local energy policy, which will result in a substantial reduction in CO_2 emissions from the residential sector, assumes the presence of an existing heating distribution network and a large capital expenditure. The atlas of the cities described in the following chapters is the basic analytical study to identify the parameters listed above.

On the basis of what said, the city can be characterized using the above-said and other parameters; on the basis of these, therefore, clusters of "similar" cities in relation to their potential for development of their smartness must be found.

Figure 1.3 represents the space of the above outlined features which offer an analytical representation of the potential of each urban context. The cities A, B and C form in this space a cluster. The "closeness" of the cities in this properly normalized n-dimensional space defines a similarity that can be exploited in reference to the possible improvement of the level of smartness of the same city.

After identifying the clusters of homogeneous cities, it is possible to assess them on the basis of some indicators of smartness. As shown in Fig. 1.3, the cities A, B and C are similar in terms of potential, while their projection in the space of smartness indicators, Fig. 1.4, allows the identification of the "benchmark city",

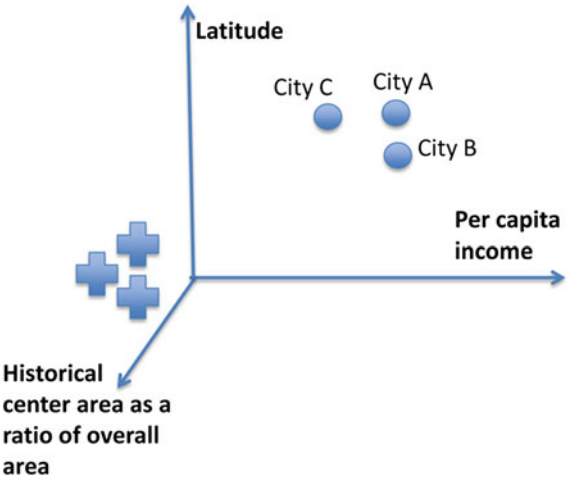

Fig. 1.3 Cities clustering

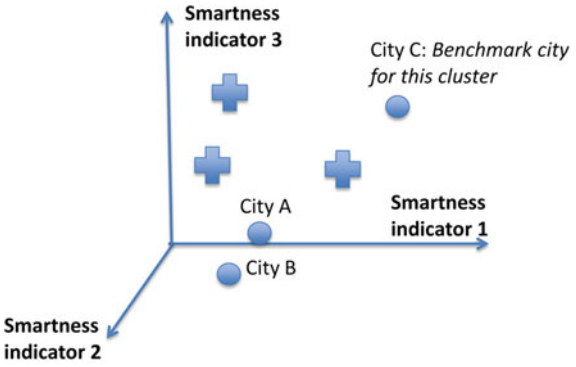

Fig. 1.4 Identification of the benchmark cities

then the model for that class of city. In the example shown, if the smartness indicators are quality indicators, the city C turns out to be the benchmark city. This allows technicians and administrators to identify the city to refer to as model of smartness and identify the measures and the most appropriate strategies in relation to their own context.

Very interesting is still the contribution of prof. Pagani [31] indicating as tools to characterize the smartness of a city some numerical parameters such as the amount of CO_2 emissions. He states that: "Indicators of this type, help to achieve superior levels of sustainability in the medium term. By using this tool to evaluate some energy and technologies smart measures for our city; we could derive useful indicators for strategies for future directions".

But the limit of the above as well as of all smart cities rankings proposed and described in the above sections is not to group the cities in the parameters space that characterize their potential. This makes it difficult to compare different urban contexts regarding some areas of decision and plans; then this allows making only a ranking of cities. Instead, what can be more interesting to study is the identification, for each homogeneous city cluster, the "benchmark" or reachable model (because it possesses similar characteristics and potential), leaving to the planner the identification of the instruments to reach the targets for the improvement of smartness of a specific urban context.

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Chapter 2
Experiencing the Smart City Concept: The Challenge of Intelligent Districts

Raffaella Riva Sanseverino

Abstract Future cities will become a complex system of variable geometry, where ICT is the main driver of all connections, an intelligent tool that enables the dialogue between different systems, the bonding agent of the smart city. The man still remains the main actor, because he redesigns his habits, corrects his behaviors, shares ideas and solutions based on continuous feedback from the environment. The areas where there are large urban innovations are the field of mobility and energy and ICT of course. Approaches to intelligent cities implementations change, because they are powered by the aspects related to communication. The dimension of the smart districts appears to be the only convincing module, able to test systems, technologies and processes. The most interesting interface to investigate is the relationship between the new city module—infact the smart district—and the citizen, city-user and actor of all urban transformations/changes; the smart city becomes progressively more closer to people, more human.

2.1 Smart City Concept

The smart city definition was given for the first time in 2007 when, based on a study of 70 European cities, their degree of innovation was measured. Six indicators [1] were chosen to build the "Ranking of European Medium-Sized city". Since then, a lot of experiences in the cities of the world have been carried out, these have helped to clarify the boundaries of these initial insights. From what we can see, the six dimensions of urban smartness (economy, governance, living, energy, people, mobility) are perhaps not sufficient to define the boundaries of all urban areas and cities of the world. Every territory, every urban area, each human environment, especially if already existing, can be reinterpreted through different elements (history, tradition, language and religious aspects, innovation, etc.) that will hand back more accurate, clearer and sharper boundaries. From here, the idea of

R. Riva Sanseverino (✉)
Smart Planning Lab, University of Palermo, Palermo, Italy
e-mail: raffaellarivasanseverino@gmail.com

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developing new analyses, which account for these new directions giving back new and different interpretations [2].

Citizens participation is a fundamental element of cities aspiring to become smart: social media (Facebook, Twitter, etc.), digital forums, E-townmeeting, Living labs, Blogs and all those new communication tools acquire a significant weight and become important, supported by new technologies, increasing connections between people to develop strategies and produce social innovation.

From all applications and projects emerge the leading role played by informed citizens (human smart city) most commonly named smart community: the opportunities to produce fruitful environments—working and doing business—arise in a new way, differently than in the past. Small businesses run by young people, hyper-specialized in making products—suitable apps [3] for city needs and problems for example—arising from simple ideas that help citizens to live better. It is the time of startups [4], which are multiplying in territories and cities, full of creative people: in USA these realities sometimes are self-financed through private donations. The video of the proposal is put on the network to attract people who want to bet on the project through donations (crowdfunding) [5].

The platform [6] indiegogo.com allows crowdfunding of innovative ideas over a limited timeframe.

Cities have always been producing innovation. Today the center of the knowledge economy is the human capital; universities, laboratories and research centers become the main factor of success and attractiveness for urban areas. With new digital technologies (3D printers for example) also manifacturing comes back to cities and innovative startups (the movement of makers, the digital artisans, the Fab Lab)[1] are all good examples. Even the recent Farm Cultural Park[2] "A place That Makes you happy" in Favara (Agrigento Province), the heart of Sicily, is ranked among the most interesting experiences in Italy of smart community: the first tourist cultural park built in Sicily. Young people, new ideas, art, culture, community projects to redevelop and implement in an inner area of Sicily.

The application for innovation from urban centers is a powerful towing factor for large productive sectors such as construction, transport, ICT, energy, health and welfare. A recent legislative Italian Decree[3] had to lead to the creation of 3000 innovative companies by 2014, but the quantitative element can not be the only parameter on which national policies and programs must be based. Others parameters must be considered: such as education, training, networking, enhancement of academic and research communities, use of public demand as a lever for innovation. It requires integrated approaches taking into account these factors aiming at fruitful connections and contamination between traditional industry and new skills.

[1]Fab Lab (English Fabrication Laboratory) is a small workshop that offers personalized services of digital fabrication. A fab lab is generally provided with a series of computerized instruments able to realize, in a flexible and semi-automatic, a wide range of objects. Among them are technology products generally considered the exclusive preserve of mass production.

[2]Farm Cultural Park http://www.farm-culturalpark.com/.

[3]Decreto Crescita 2.0/2012.

The lowest level of application of the smart city concept is the urban district dimension, whose exact boundaries are neither specified by morphological or historical elements, nor by purely functional aspects. Other interpretations, more multifaceted, possibly relate to the contemporary dimension with elements of vulnerability that are proper of the district. The size or the district boundaries may vary depending on the specific urban function, or may not even be specified in other cases (projects on cloud).

To mention an Italian case, the recent example of Cinisello Balsamo (near Milan), where (2013–2015) the Town Council has implemented a project called "Cinisello Balsamo Digital District" [7], shows the benefits from the introduction of new technologies in the Italian schools. The project involves 4600 students of 17 primary and secondary city schools.

Each of the 218 classrooms of Cinisello Balsamo was cabled for internet connection and equipped with an interactive multimedia e-board.

Switching from digital district to physically measurable district, the urban brownsfields offer an interesting testbed for the intelligent urban transformation experiments—as it happened in some Brazilian cities with old industrial districts turned into Science and technology parks.

Says Eduardo Moreira da Costa [8] "A smart city is a cluster group (neighborhoods) of 1 square mile, where people can live happy, work and play in the same space, connected by a good quality of public transport. The smart city is not just a matter of space, but it involves many aspects, such as energy, government, environment etc. The new and intelligent Scientific Park will be integrated with the local community, the neighborhood and the environment in which it is located…. and since Science Parks are fashionable, it is a good place to start to change our way of looking at the city, integrating local communities with the goal of improving the social aspect of the surrounding area".

The smart city and intelligent districts of any type are a way to create new central areas in contemporary cities and at the same time are a way to fill with new cultural contents parts of the city. It is an opportunity that should not be wasted, but should be considered as a challenge in the direction of sustainable urban development. The Brazilian city of Florianópolis, for example, the capital of the Southern state of Santa Caterina, is building *florip@21*, a prototype of a major change in the city and an example for the all the Country.

The project is developing a plan for the integration of a Science and Technology Park (PST) in the urban area located in the periphery. Still Moreira Da Costa says: "All the districts of the new smart city must involve the population (Human Smart City) in the changing processes of the deprived areas that must be regenerated and the key to doing this is the promotion of social innovation through new entrepreneurs, new businesses and job opportunities. The creative industry, for example, which is so important for smart cities, is based on talents in a general sense. After government intervention in the Rio favelas, for example, the new coffee shops and restaurants are attended by tourists and locals. In these places are frequent cultural

shows and demonstrations. At this time, such as it was the creativity some years ago, now the social innovation is the key to change".

More in general then, the size of the energy district has once again its own characteristics and different outline based on context and aims. If it is created with the specific target to reduce energy consumption, it has a size that depends on the number of users (consumers), that is useful to aggregate to obtain the main objectives of energy efficiency improvement also considering technical infrastructures and of reduction of resources consumption.

To create aggregations and districts some features are important, as we can see in recent global studies [9]: particularly the construction period of buildings, the building type and urban morphology [10], the population density and then the existing national legislation, that has a decisive role.

The concept of integrated urban system seems to be the key to understand what the smart district is, as the example of Carros shows. The involvement of citizens for the purpose of containing consumption appears an important factor as evidenced by the project of smart solar district in Carros, a small town a few kilometers from Nice (France). The owners of the Malongo [11] Coffee Factory through participation in the competitive European program Grid4Eu decided to upgrade plants with Nice Grid project [12].

A key element of the project, to which also Alstom took part, is the integration of various energy resources in an urban area, where photovoltaics, lithium batteries and special smart meters allows to get a 60 % saving compared to previous consumption. Through this project, the local companies want to gradually change their energy profile becoming an active part of the process. With the entrance of the initiative in its practical phase, the citizens also have been involved. The company EDF (Electricité de France, the largest producer and distributor of energy in France) is looking for volunteers who are willing to become prosumers (producers–consumers), by deploying solar panels and smart meters. As this experimental project and others demonstrate, the smart city is always based on a project where the community has a central role to achieve shared objectives.

Another recent experience in two french cities in Normandy (Flaubert and Luciline) concerns the construction of eco-neighborhoods and smart districts, thanks to funding granted by the EIB (European Investment Bank) to be transferred to the national project of Rouen-Elbeuf-Austreberthe Metropolitan Community (Metropole Rouen Normandie-MRN). Two intelligent districts, Flaubert and Luciline, brought forth by the MRN and Rouen City, will house approximately 13,000 people and will feature technological solutions oriented to energy efficiency, sustainable mobility, improving quality of life (pedestrian areas, bike paths, accessible and well-equipped green areas), ultra mobile and fixed broadband to offer companies and citizens modern facilities (applications, widespread access, digital economy apps). Very soon will be ready the first 1000 homes built according to the new standards (smart building), which will integrate the objectives of the European project "Future Cities–Urban networks to face climate changes" [13].

Intelligent districts, more inclusive, where it's possible to share solutions to improve quality of life. In France, since 2013, funding about 5 billion Euro have been provided by the EIB. These are intended for the implementation of national and local projects of smart city, innovative infrastructures, urban regeneration, tackling climate change and enhancement the environment.

2.2 Mapping Smart Cities

An interesting report [14] recently delivered by the European Commission makes a real mapping of the status of implementation of the smart cities concept in Europe.

The study shows some analytical data, characteristics and ways of reading smart cities according to current literature and makes some assessments on critical issues.

Indeed, there are cities that are on the path that will lead them to become fully smart in 28 member states, but these are not evenly distributed.

The states involved in projects and initiatives concerning smart cities are mainly: England, Italy, Spain, Sweden, Estonia and Slovenia. Very often the drivers involved in the projects are: Smart Environment and Smart Mobility.

There are many definitions of smart city, some focused on the use of ICT as an enabler and a driver technology, while the broader definition includes socio-economic aspects, with a multilevel governance, using citizens participation to improve sustainability, quality of life and welfare.

In any case, a smart city develops around the use of technology (in particular the function of ICT is central) to improve competitiveness and to ensure a more sustainable future through networks, that interconnect people each other, companies, consumers (prosumers), energy carriers, spaces etc.

A smart city is also a city that tries to address public issues through joint solutions, based on a multi-stakeholder municipal partnership. Other drivers—mobility and energy—are involved in initiatives that often intertwine and make an entire picture with an intelligent telecommunications infrastructure, creating a real intelligent engine putting everything "in the system".

These solutions are developed and improved through smart city initiatives, as projects or (more often) as a network of overlapping activities. More concretely, strategies and initiatives for smart cities are placed at least in one of the following areas: smart governance, smart people, smart living, smart mobility, smart economy and smart environment. The areas described include some goals that stakeholders will reach by taking part to some of the smart city initiatives (for example, to solve an environmental problem). The means by which these objectives are achieved are very different and range from technologies, materials and processes to rules. These means may already be in place or may be the subject of innovative development for their use in specific initiatives for *smart cities.*

2.3 Successful Smart Cities Initiatives

The story, that successful smart cities projects tell, is that initiatives with clear goals and with a very strong public-private partnership are the winning ones.

The European study mentioned before clears out the importance of democratic participation of citizens in programs for smart cities to avoid increasing the gap between the urban elite and disadvantaged citizens.

The case studies highlight the most important facts in the cities that have experienced numerous successful initiatives. Citizens must have the power—through the active and democratic participation in the project carried out in the city—to strengthen the sense of community. It is important to promote participatory environments that facilitate and stimulate businesses, the public sector and citizens to contribute. The creation of a central office—Urban Center, UC[4]—at the municipal level to act as a coordinator for smart city ideas and initiatives is vital and allows coordination of ideas, projects, stakeholders and interested parties, since an important matter in the project development is the partnership and its proactive operation in time.

The coordination at the local level can be important in order to ensure the integration of solutions across the portfolio of initiatives. For example, many municipalities underline that information on public services should be provided in an open mode as "Open Data". This allows citizens and companies to develop and recombine data that may be of public utility, with other available data in order to create resources and services for citizens; for example, in real time traffic information to produce intelligent management tools.

The implementation of Open data provides the basis for participation in knowledge networks among cities, created in order to share knowledge and experiences, promote their activities and learn from others.

The evolution of the smart city concept of smart city is shaped by a complex mix of technology, social and economic factors, governance mechanisms and drivers related to politics and affairs. The implementation of smart city, therefore, follows very different paths depending on the objectives, funding and size of each city.

There are indeed many other terminologies related to the smart city concept:

- City of knowledge.
- Sustainable city.
- Talented city.
- Creative city.
- Digital city.
- Ecological city.
- Wired city.

[4]The interest in the UC phenomenon is linked to the evolution that these facilities can represent for local government authorities. A good opportunity to try out new forms of participatory and deliberative democracy, not limited to the aspects of passive communicative-informative, but aimed at building shared guidelines on new urban policies (www.urban-center.org).

Many of the above definitions are focused on the key role of ICT connecting the city services and monitoring the city in real time [15], as Carlo Ratti does within the Senseable Lab of Massachusetts Institute of Technology, MIT, Boston.

For example, a city is smart when:

"The use of ICT makes the infrastructure components and services smarter, interconnected and efficient…". And again: "We take the particular perspective that cities are systems of systems, and that there are possibilities of introducing digital nervous, intelligent optimization and responsiveness at all levels of systems integration…" [16].

C. Ratti says: "The city in real time is now real! The increasing use of electronic systems and sensors in recent years is allowing a new approach to the study of the built environment. The way we describe and understand cities is being radically transformed along with the tools we use to create them and the impact on the physical structure".

Through the use of ICT (Internet of Things a city can become smart optimizing the efficiency and effectiveness of processes, activities and services that are useful to the city itself. This optimization is met by combining elements, objects and different actors in a more or less transparent interactive and intelligent way. In this sense, the smart city concept can be seen by recognizing the growing importance of digital technology to improve the competitiveness of a city, as well as to ensure a more sustainable future, through networks of people, companies, technologies, infrastructure, consumption etc.

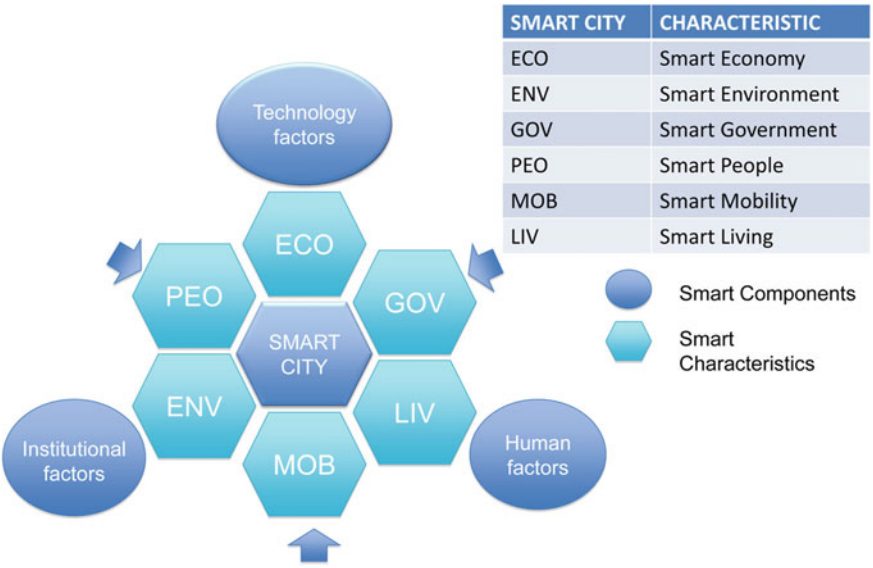
In general, ICT enables cities to:

- Make smart access to data, information, and processes "Open Data";
- Create new relationships between governmental structures (smart city governance);
- Guide innovation through living labs and tech hubs[5];
- Ensure synergies and interoperability with/between domains and political systems (transportation, energy, education, health, utilities,…).

In the diagram below (Fig. 2.1) the relationship between different components (infrastructural, technological and human) and features of the smart city (economy, environment, government, people, mobility and living) are shown. The outer ring shows the components and the inner ring the characteristics. Rather than each physical component mapping onto a specific characteristic, a range of technological, human and institutional factors underpins all characteristics.

This allows understanding the relationships between physical components and characteristics as both direct and indirect. In some cases, the characteristic fully

[5]High tech hubs are physical and virtual environments in which technology startups can grow quickly. The idea is to put in the same place entrepreneurs who want to invest in new technologies and young people with new ideas and skills.



SMART CITY	CHARACTERISTIC
ECO	Smart Economy
ENV	Smart Environment
GOV	Smart Government
PEO	Smart People
MOB	Smart Mobility
LIV	Smart Living

Fig. 2.1 Characteristics and physical components of the smart city. Image processing from [14]

describes the initiative by displaying what the initiative is about and the priorities of its participants and direct beneficiaries.

In other cases, the characteristics are a vehicle for the physical components; the initiative is primarily a way to bring people together and create new ways of collaborating. For example smart governance is a vehicle for the implementation of a participative electronic platform.

This is the case when the primary contribution is to the Smartness of the city itself.

"In some cases, the linkage from objectives to characteristics to components is direct; an objective is furthered by a specific initiative with an associated characteristic that necessitates and justifies the use of a particular physical component. Take, for example, the objective of improving energy efficiency within the city. This objective may be associated with an environmental initiative (characteristic), which makes use of Smart buildings (component) to permit energy network managers to adjust load in order to make efficient use of existing supply capacity. The linkage may also be indirect, if a specific physical component contributes to more than one characteristic, altering the way those characteristics are pursued across other initiatives and their associated components and objectives. We can see this type of linkage in the above example. Here, the use of Smart meters can help individual energy users to optimise their demand patterns (contributing to the environmental characteristic)."

2.4 Horizon 2020: The Strategic Pillars

The Horizon 2020 funding [17] is organized on three strategic pillars:

1. *Excellent Science* (24.6 billion Euro), designed to secure Europe's leadership in world science.

   It consists of four programs:

- European Research Council: It supports the most talented and creative people and their teams in carrying out frontier research of top quality;
- Future and emerging technologies: Finances collaborative research to open new promising fields of research and innovation;
- Marie Sklodowska Curie Actions: Offers excellent researchers opportunities for training and career supporting mobility;
- Research infrastructures: Ensures that Europe has the research infrastructure (including networked electronic infrastructure) of world-fleece them accessible to all researchers in Europe and other countries.

2. *Industrial Leadership* (17.9 billion Euro) aimed at supporting research and innovation of European industry, with a strong focus on the enabling technologies and investments to small businesses.

   It consist of five programs:

- Leadership in enabling and industrial technologies;
- Nanotechnology, advanced materials, biotechnology, advanced manufacturing and processing;
- Space Technology;
- Access to risk capital;
- Innovation in SMEs.

3. *Societal Challenges* (31.7 billion Euro), aimed at fostering a greater understanding of Europe, by providing solutions and support inclusive, innovative and reflective European societies with an innovative public sector in a context of unprecedented transformations and growing global interdependencies.

   The major global challenges in the areas:

- Health, demographic change and wellbeing;
- Food security, sustainable agriculture, bio-economy;
- Secure clean and efficient energy;
- Smart, green and integrated transport;
- Climate and Resource Efficiency (including raw materials);
- Actions for an inclusive, innovative and reflective society;
- Actions for a safe society.

These are flanked by five cross-cutting programs:

- Spreading excellence and widening participation;
- European Institute of innovation and technology (EIT);
- Science with and for Society;
- Joint Research Center;
- Euratom.

Horizon 2020 provides, among Societal Challenges (Clean and safe energy efficient) and through participation in the call SCC Smart cities and communities (2014–2015), the opportunity to test and develop in European cities, intelligent districts. The definition of smart districts according to the European Commission is determined of particularly creative urban environments, which look at technological innovation and processes. The affected areas are those considered key factors of the smart city: the scope of mobility and transport, the energy sector and, finally, ICT, real enabler of the city that wants to become smart. The breakdown of the partnership is expected that it should host at least 2 or 3 cities leader and 2 or 3 followers cities, belonging to the European Union. These latter are willing to share practices and processes with the top three cities. The feature of the partnership is essential and works on both the local and on the transnational European dimension. Some cities have come together in stable consortia and are participating in the challenge with various projects that have already been selected and that is having significant funding from the EU. In 2014 were presented in this category, 19 projects and 3 of them were selected: Triangulum, Remourban and Growsmarter. Triangulum was also selected as the strategic partner in the EC Horizon 20-20.

2.4.1 European Smart Cities Projects Funded in 2014/2015: Smart District in European Competitive Project

REModel for smart URBAN transformation [18].

Key factors

Leader cities: Valladolid, Nottingham, Tepebasi
Follower cities: Seraing, Miskolc
Funding: Horizon 2020
Timig: duration 60 month
Start date: 1st Jan 2015.

The project proposes a sustainable urban regeneration model leveraging the convergence of energy, mobility and ICT to transform European cities into smart cities. Energy, transport and information and communication technologies (ICT) are key to achieve economical and societal benefits and improve citizens' quality of life. They also represent most of the interrelations between people and technology.

A big challenge to offer new interdisciplinary opportunities to make cities smarter is already open in the common area where energy production, distribution

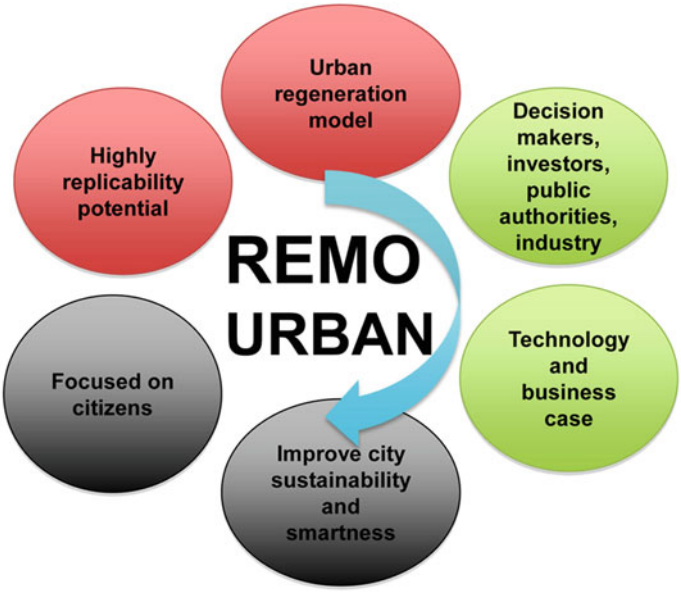


Fig. 2.2 The Remourban concept. Image processing from Remourban site

and use, mobility and transport, ICT work together and are intimately linked. The project is fully aligned with the Smart Cities European strategy and involves three lighthouse cities and two follower cities.

Remourban (Fig. 2.2) is implementing large scale interventions and intense dissemination initiatives to demonstrate the potential of the urban regeneration model in the energy, mobility and ICT sectors.

The cities that are involved in the project are Nottingham (UK), Valladolid (Spain) and Tepebasi Eskisehir (Turkey). The followers city, according to the same scheme of the project before exposed, are: Seraing (Belgium) and Miskolc (Hungary). This project demonstrator (or flagship project) will last 5 years and intertwine in an integrated way the three themes of transport and mobility, energy and ICT.

In Nottingham the partnership is formed by a local partner (Municipality of Nottingham), an industrial partner based in Nottingham (energy company) and an academic partners (University of Nottingham) in addition to two other small and medium-sized locals enterprises.

They form strong partnerships with local leaders and municipal authorities to get the life support and the necessary visibility to engage and empower citizens and local stakeholders to reduce greenhouse gas emissions and energy consumption,

and more generally to improve urban environment. City leaders develops new solutions independently, according to their local needs. These solutions and innovations are then shared between the five cities (city leaders + followers city), to develop repeatable solutions for cities. Nottingham has adopted in recent years a series of actions and measures to reduce harmful emissions (targets of Climate Package 20-20-20). The city has, including its hinterland, 1,000,000 inhabitants. The area around Sneinton Road, in Nottingham, was considered as the most appropriate site for the development of Remourban project. The site is very close to the existing district heating plant. In the same area there are the municipal property housing and social housing, which need to upgrade to a more efficient energy use. Near the site we will also find one of the most famous cultural landmarks of the city—the Windmill and the city of Sciences.

The project is focusing on a variety of building types present in Nottingham in Sneinton ranging from apartments with one bedroom to three-bedroom townhouses, built between 1900 until 70s. A large number of properties (65 %) of the area are social housing, owned by Nottingham City Council (NCC) and managed on their behalf by Nottingham City Homes (NCH). However the energy retrofitting interventions are open to all owners within the streets of the area defined by the perimeter and in all types of properties. Despite the variations in age and type of construction, the most common feature of building structure in the selected area is the lack of insulation of walls: they were built with full bricks, lime and various types of coating, curtain structures with uprights wood.

Areas of study involved in the project are:

1. *Energy*. Intervention on the building envelope. Building envelope insulation to achieve high levels of energy efficiency (Passive-house System++) of the various types of buildings in the neighborhood. As part of the programme of adaptation, it is proposed to restructure a nine-block houses in West Walk (Sneinton) with a high energy efficiency standard Passivhaus. In addition, this experiment carried out on a series of different building types will also become a valuable guide for local installers.
2. *Energy*. Intervention of district heating plants: the existing district heating network is upgraded (4700 homes) using the low temperature heating adopted systems for the first time in the UK. The thermal storage units are being connected to the solar system on the housing roof to add more on-site generation from renewable energy sources.
3. *Ict/Energy* (Energy box) An intelligent energy measurement system will be present in every home, equipped with appropriate tools for the energy count. The system will provide double the flow of information; one for the energy provider, in order to improve the accuracy of billing and the other for the consumer. Consumers will be able to assess their own energy consumption within their apartment with a device (Energy box) and will be able to regulate their own energy consumption.
4. *Ict*. ICT architecture is expected to develop an integrated model of ICT infrastructure that will join on-line simulation models for each of the constituent

elements of the project (mobility and energy): ICT for citizens, ICT for energy consumption and ICT for transport infrastructure.

5. *Mobility.* Touristlink. Nottingham is a leader in sustainable transport. It is the first city in the UK to have an environmental standard line-gnawed for all buses entering the city center. Nottingham City Council is developing a fleet of 50 electric buses existing links: electric buses are zero CO, NOx and PM, 50 % less well-to-wheel CO_2 diesel counterparts. The Cost savings are estimated at more than 10,500 Euros for the bus a year (depending on the fuel economy of the service more cost cycle). The project aims to initiate a Touristlink bus service using two electric vehicles on a circular path. The electricity to recharge the buses may be provided by Enviroenergy, fueled by the burning of waste in the city, representing a further approximately 40 % carbon savings compared to conventional diesel buses. Last Mile Delivery. The project will also develop a small local delivery center for 5 km. The last mile delivery will include the use of small electric vehicles for the transport of goods in the city center, reducing the number of vehicles of large dimensions used for domestic and business deliveries. The solution is scalable, cost-effective, makes more effective use of existing infrastructure and offers particular benefit to the environment of cities and towns. The project incorporates the City card Car Club Nottingham, funded by the local government also provides for the withdrawal from the workplace. The scheme is an alternative to car ownership and car hire in the traditional way and offers a more environmentally friendly transportation options for local residents with the use of hybrid or electric vehicles.
6. *Social Inclusion—Social networking.* The project encourages the proactive involvement of citizens, who sometimes are excluded. It is a platform with which the citizens not only learn from each other and join together in decision-making for their communities through better awareness and information. The project supports a distributed approach to the city by strengthening the interaction and involvement of citizens at hyper-local level, through social networking. This view has its roots in the participation and cooperation through modern technologies is enhanced through social exchange in a citizen engagement framework in which people are "at the heart" to understand what their neighborhood needs, how to implement it, and the best way to work with the neighboring areas for mutual benefit.

Triangulum [19]
Key factors

Leader cities: Manchester, Eindhoven, Stavagar
Follower cities: Leipzig, Prague, Sabadell
Funding: Horizon 2020
Project duration: 02/2015–01/2020.

The Triangulum project is one of the three European Smart Cities and Communities Lighthouse Projects, providing solutions and frameworks set to

demonstrate, disseminate and replicate for Europe's future smart cities. Project winner of a first selection of European call SCC Smart city and communities, Triangulum develops the concept of intelligent urban district in three European cities. The flagship cities are Manchester (UK), Eindhoven (NL) and Stavanger (NO) will serve as a testbed for innovative projects focusing on sustainable mobility, energy, ICT and business opportunities. The project consortium combines interdisciplinary experience and expertise of 22 partners from industry, research and municipalities who share the same objective and commitment to develop and implement smart solutions in order to replicate them in the three follower cities Leipzig (D), Prague (CZ) and Sabadell (ESP). The overall budget of Triangulum is 30 million Euros (2015–2020).

The European Commission funding (Horizon 2020) accounts to 25 million Euros. The project is coordinated by Fraunhofer IAO in Stuttgart and supported by the Steinbeis-Europa-Zentrum.An exceptional feature of the project is the ICT architecture and smart city framework that will be developed in the flagship cities and rolled out in the follower cities. A modular approach will enable flexible (business) solutions that address individual challenges and requirements of our cities and their stakeholders.

In **Eindhoven** (NL) two districts are being transformed into sustainable living environments during the course of the project. The former Philips industrial complex situated in the Strijp-S neighborhood will become a creative and intelligent district. An innovative way to convert the abandoned industries areas will also become a means to generate energy. A wide range of ICT solutions will enable differently to citizens to lease electric vehicles of different types. In this way through the new ICT equipment, the citizens will be helped to develop sustainable behavior in the energy sector and in transport. A district-wide ICT solution will allow residents to access different kinds of infrastructure, such as booking electric vehicles from a district car sharing scheme or using smart parking concepts. In addition, electric buses will make city traffic more eco-friendly.

In **Stavanger**, electric vehicles are already a familiar sight. In spite of this, the city with the highest density of electric vehicles in Europe would like to be a motor for development and growth. A high-performance fiber optic network will ensure that data can be exchanged very rapidly. Citizens, enterprises, research institutions and the health sector will benefit from the high-speed ICT infrastructure which will improve planning, reduce energy consumption and enable telediagnosis.

In **Manchester** Triangulum is turning a student quarter for ca. 72,000 students into a smart city district. This will entail retrofitting of historical buildings and building up an autonomous energy grid to supply the entire district with heat and electricity. The grid will combine geothermal and district heating with two independently operating electricity grids and a fuel cell that can store excess energy. Traditional cars are banned from the new district: in accordance with the vision of the authors of the project will only be allowed electric vehicles (bicycles, scooters etc.) and will be built in the neighborhood electric tram line. As a result, another secondary aspect of the project is to promote civic engagement and citizens

participation through workshops. "At the heart of our project is an architecture ICT, which will be used in all three leading cities," says Alanus von Radecki, the creator ICT architecture. This standardized architecture also ensures that will later be possible to transfer the concepts in other cities (Leipzig, Prague and Sabadell), when the project entered its second phase to be improved.

GrowSmarter [20]
Key Factors

Leader cities: Stockholm, Barcelona, Cologne
Follower cities: Graz, Porto, Cork, Valetta, Suceava
Funding: Horizon 2020, Call Smart cities and communities
Duration and timing: 60 months
Starting: 1st Jan 2015.

In a rapidly urbanising world cities need to become smarter to respond to citizen needs and to reduce their environmental footprint. GrowSmarter brings together cities and industry to integrate and demonstrate '12 Smart City Solutions' in energy, infrastructure and transport topics, to provide other cities with valuable insights on how they work in practice and opportunities for replication. The idea is to create a ready market made for these smart solutions to support growth and the transition to a smart, sustainable Europe. The idea is to create a business case to initiate market roll out in the Follower Cities and the rest of Europe.

Smart Solutions 1: Low Energy Districts

Developing low energy districts is the first of 3 action areas on which the GrowSmarter project will be focused. The main challenge in 'Sustainable Districts and Built Environment' is to reduce energy use, environmental impact and carbon footprint. Currently our existing building stock plays a major role in energy consumption (40 % of EU final energy demand). This stresses the need for affordable and sustainable retrofit solutions at a large scale. The starting point of the actions is the building itself and the focus on cleverly combining and fine-tuning solutions on the market for existing as well as new buildings and districts.

Smart Solutions 2: Integrated Infrastructures

Integration of new and existing infrastructure is the second of 3 action areas on which the GrowSmarter project will be focused. Significant and as yet insufficiently tapped value is offered by integrating both active and passive infrastructure networks within and across cities—be they energy, transport, communications or others—rather than duplicating these needlessly. Many such infrastructures are ageing; budgets to replace them are stretched; they are procured and managed 'in silos'; so the potential for cities and their customers through new joined-up approaches, exploiting modern technologies is substantial.

Smart Solutions 3: Sustainable Urban Mobility

Sustainable urban mobility is the third of 3 action areas on which the GrowSmarter project will be focused. Improved mobility for citizens and businesses can make cities could be more attractive and competitive. Meeting Europe's 20/20 goals, tackling congestion, improving air quality, accessibility and

sustainability in most cities will require substantial changes in the transport system and operations, and in the mobility behaviour of people and businesses. Too many vehicles in cities are powered by oil, and alternative fuels are under-used. Public and other transport services, timetables and ticketing, and interchanges are not always well connected. Innovation, a re-think of public-private sectors cooperation and how to engage citizens more directly in new mobility systems and services is essential.

2.4.2 *Intelligent Districts*[6] *in Southern Italy: The Operative National Plan Research and Competitiveness Smart Cities and Communities*

In 2012 the Italian Ministry of Education, University and Research (Decree n. 84/Ric. March 2nd, 2012) has launched two programs, one targeted to the submission of project ideas for "Smart cities and communities" and another for "social innovation projects". The test areas are those in the Southern (Convergence Regions): Sicily, Puglia, Campania and Calabria. The bet is the creation of intelligent districts, where small and medium-sized enterprises, research centers and universities, public administrations are the first actors, because they are called to integrate expertise to develop innovative solutions, through the most advanced technological tools. They can, in this way, contribute to the development of the territories and respond to the real needs of the community to improve the quality of life of citizens. The thematic areas are so many hinged in common thread of smart city: Cloud computing technologies for smart government, Smart culture and tourism, Renewable Energy and Smart Grid, Energy Efficiency and Low carbon technologies, Smart mobility and Last-mile logistics, Sustainable Natural Resources (waste, water, urban biodiversity) as well as smart health, smart education etc. Projects that began in 2013 have been completed in December 2015.

2.4.3 *The National Technological Cluster "Technologies for Smart Communities"*

In early 2013, the Italian Ministry for University and Scientific Research endorsed the Cluster for Intelligent Community Technology[7] [21] and published a call to promote the construction of major national aggregates, such as science and

[6]The author of this chapter has been part of *I*-Next project, winner of the competitive national Call Smart cities and communities (2012–2015), drafting the Sustainable Urban Building Regulations for Palermo (Italy) tool of local authorities to achieve sustainability goals.

[7]http://torinowireless.it/national_cluster_smart_communities.

technology parks, in nine major areas of strategic interest (energy, intelligent factory, technologies for Smart Communities, mobility etc.).

Projects approved by the Italian Ministry of Education, of University and Research in the cluster intelligent communities are the following:

1. The educating city;

The education city project (2014–2017) [22] considers education as a key concept for the development of intelligent communities. Education that creates human capital, which creates cognitive and social skills, participation and democratic sense. It offers a rethinking of the traditional learning environment and the role of educators, developing educational approaches, based on the systematic use of new information technologies, networking and social networks, starting from the school but involving the whole community to create ecosystems for teaching and continuous learning over time and space (lifelong learning). Four demonstrators were made by age groups: 3–12; 12–18; 19–25. Further: life-long-learning by involving young children, teachers, pedagogical coordinators, families and companies.

Regions involved (companies and research centers): Emilia Romagna, Lazio, Piemonte, Trentino Alto Adige.

2. Social Museum and Smart Tourism;

The project concerns the new management tools of tourism-related activities: how to improve the use in cities of cultural heritage; how to exploit new technologies to create open museums and qualified services to visitors. The goal is to facilitate tourism and cultural experience by offering services and qualified information that optimize visit time, suggesting opportunities on the basis of personal interests, providing appropriate and affordable tourist services. Florence, Rome and Venice are the three cities in which to test the news related to research, including the formation of new professionals: for example, audiovisual professionals to create virtual paths within the artwork.

Regions involved (companies and research centers): Lazio, Toscana, Veneto, Piemonte.

3. Buildings in Zero Energy Consumption in Urban Intelligent Districts [23];

The project aimed to improve the energy efficiency of buildings, and more generally the urban districts, through a pervasive use of monitoring technologies and real-time monitoring of environmental parameters and consumption/production of energy. The demonstrator of the project carried out on the territory of the municipality of Settimo Torinese, that is characterized by the size (32 km^2) to allow the replication of the demonstrator in other municipalities and for the opportunity to engage in a different era experimentation public and private buildings, type and intended use.

Regions involved (companies and research centers): Liguria, Lombardy, Piemonte, Sicily.

4. Eco intelligent mobility [24];

The project pursues the environmental impact of transport and enhanced security for the public and private urban mobility of goods and passengers. It offers a holistic approach, where vehicles and infrastructure are designed to co-operate effectively in order to optimize the mobility needs of citizens and services, minimizing the transportation costs (e.g. fuel costs) and environmental impact (e.g. pollution, noise, congestion). The trial will take place in three venues, Expo 2015, the City of Turin and the back port of Genoa.

Regions involved (companies and research centers): Liguria, Lombardy, Piemonte, Sicily.

2.5 The PON Metro and the Palermo South Coast Intelligent District

The PON Metro Project involves ten[8] Italian metropolitan cities. The Program "Palermo South Coast" by the PON Metro 2014–2020 [25] financed by the Ministry of Economic Development is another important step aimed at overcoming major environmental challenges: first of all, achieving lower greenhouse gas emissions as part of European commitments, outlined in the Climate Energy Package 20-20-20 in the context of the Palermo metropolitan city. The achievements and actions included in the project will be completed within the next 5 years (the request to the Ministry responsible at the end of last December is about 130 million Euro of funding) and will concern primarily integrated actions in the field of sustainable mobility, energy efficiency and social inclusion.

Already the city of Palermo in 2013 had approved the Action Plan for Sustainable Energy [26] preceded by adhesion to the Covenant of Mayors. The Southern Coast of Palermo, while being an area with high landscape value, full of historical preexistences (architectures and coastal settlements) presents relevant problems of economic, social and physical decay. Industrial waste (industrial systems abandoned), interstitial spaces, free abandoned areas to reconfigure, infrastructure remains. The urban fabric with residential function looks devoid of any

[8]Milan, Turin, Venice, Genoa, Bologna, Florence, Bari, Naples, Reggio Calabria, Rome—and 4 metropolitan cities of the regions with a special statute—Cagliari, Catania, Messina and Palermo. The objectives are: increasing sustainable mobility in urban areas, reduction of energy consumption in public facilities, the spread of digital services (joined up services) and the promotion of social inclusion and poverty reduction interventions. In particular, interventions for the city of Palermo regarding the Integrated Territorial Area 3 (Maredolce, Brancaccio, Bandita) and the Integrated Territorial Area 6 (Gasometer, Macello and Romagnolo) and, in small part, even the municipalities of Misilmeri and Villabate.

urban quality (dormitory suburbs built between the 70s and 80s): historical village of the maritime system that characterize the area has disappeared as occurred in other coastal areas of the city, having undergone intense urbanization since the war.

Recently some urban interventions have created development opportunities for the city and for the whole area and new territorial unbalances are not yet offset: in particular, it refers to the construction of the infrastructure network for public transport (tramway) and the commercial area construction (Forum shopping center) in the Brancaccio area with other services and some specifical areas for trade destination.

The coordinated actions of environmental matrix that are proposed in the Palermo Pon Metro project are in the following sectors and intercept all the themes of smart city trying to intervene on the area weaknesses on the path of a more human smart city [27].

Sustainable mobility

- Intermodal Point;
- Car and bike sharing;
- Electric bus fleet;
- Charging systems for electric buses;
- Cycle routes;
- Energy efficiency;
- Redevelopment of public lighting and traffic light;
- MEI Point;
- Smart City Expo;
- Project efficiency in schools.

Social Inclusion

- Develop monitoring paths to residential autonomy of persons with disabilities and/or elderly by strengthening the role of the municipal administration governance, improving the supply of services;
- Strengthen the relationship with the Third Sector by implementing structural services in strong public value but to manage through the involvement of them and the beneficiaries themselves;
- Create a network of temporary accommodation housing for supporting social inclusion and support to output paths;
- Improving provision of services for individuals with fragile allowing a total care of the subject making it easier to escape from marginalization path through the enhancement of their personal resources to get out of the welfare circuit and reducing the harm to the so-called diehards.

Actions related to e-inclusion

- Literacy of disadvantaged groups, reduction of social services costs and increased efficiency in the use of resources (social workers), emergency housing reduction. Dematerialization and development of knowledge: digital development of cities leads to virtualization of many area;

– De-mobilization: opportunity to rethink the use of the spaces and thus also the choice of displacement, with multifunctional areas in homes, useful for both work and social life, which can make the mobility a choice to visit external area.

The European Commission approved in July 2015 actions and proposals of the Pon Metro Palermo; now it's up to the National government to directly carry out the transfer of funds to the municipalities involved in the project for the so-called metropolitan areas.

2.6 Intelligent Districts: Two Different Patterns

Some of the projects presented in the chapter are examples, test cases, sometimes far from real life of cities but useful for the analysis of some specific situations. The most recent global demographic studies point out that in 2050 the world urbanization trend is set to continue [27]: consequence of this attitude the birth of countless urban centers all over the world with huge concentrations in Asian region. It is well known that that the most energy-intensive sectors of the urban energy system are the building and the transport sector. In this perspective it is necessary to reverse the trend, re-thinking intelligent cities, designing low-emissions settlements and developing new operative urban solutions for the "already built". The smart city and the district urban module dimension offers the opportunity to test strategies, processes and methods and to change the trend.

The various projects as seen in the present chapter reflect the difficulty in testing a new and bumpy path, suitable for each city, that intercepts people, places and systems.

The drivers involve different sizes and scales to be integrated together in the urban dimension (environment): mobility, energy, made through smart ICT components, glue of the smart city as the paragraph above reports. The energy sector is one of the key areas of the turnaround in the field of smart city.

Cities in the world, are very different in characters, size but also history, people, use, building density, energy consumptions and emissions: some of them are the result of ancient layers, difficult to manage (what we can call approximately Mediterranean pattern), others brand new designed already with another logic, but less true (Global pattern) and maybe more climate-changing, especially in a global and overall urban metabolism perspective [28].

Representative of this second trend is the Masdar City model, belonging to what can be called a "Global pattern": the smart urban district becomes a data measuring system, a test grid on which it is possible to identify new relations and carry out studies as on white paper. It becomes easier as part of a defined environment, organized with regular mesh blocks, run surveys in several strategic areas of smart city, as the Masdar district of Abu Dhabi (Arab Emirates) shows. In this pattern the urban energy drivers seem to be defined by the infrastructure networks and from an integration designed of the urban energy system (waste, mobility etc.).

The smart district recently built in Stockholm city shows instead a systemic approach of the eco-cycle model (Mediterranean pattern). Rappresentative of this approach is Hammarby Sjostad District [29]: the Hammarby model, which is the district's attempt at a balanced, "closed-loop urban metabolism", accounts for the unified infrastructure of energy, water and waste. In addition to the Hammarby Model infrastructure, the presence of urban-scaled density, access to multiple modes of transport with an emphasis on reduced car commuting, preservation and restoration of existing natural systems, and progressive construction and housing policies make Hammarby Sjostad an "effective demonstration that ecological and urban go together" by means of comprehensive planning [30].

The second pattern is best suited for European cities, where every intervention tries to connect to the metabolism of the whole city.

The size of the smart districts and then the project of an integrated and systemic form [30], that the district can represent, can be used to go beyond the building dimension: from the district to the city, rethinking it integrally, as a whole, with a holistic perspective, designing with an interscalar and cross logic, giving out new and different scenarios in various cases as each city would respond differently.

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Part II
Smart City Atlas

There are now many different, sometimes competing, ecological city-building models out there, and which ones are most useful or relevant remain an open question. There is no single model (nor should there be). Our immaginations have been captured by the hi-tech, tabula rasa projects like eco-city Dongtan in China (now scratched) and Masdar City (under construction) in Abu Dhabi. There is a strong argument to be made that our best examples are ones that build onto and improve the existing conditions of already present cities, suggesting the importance of London or Vienna or Lyon, not Masdar (though I do believe there are things to learn from this new town as well). The Journalist Chris Turner writes "In a place like Masdar, you might find some fascinating future-sense technologies, but if you're looking for the state of the art in complete street design, mixed-use development and multi-modal transit in urban sustainability , that is – then Copenaghen's the place to go".

T. Beatley, *Green Cities of Europe*,
2012 Island Press

Chapter 3
Smart Cities: Case Studies

Eleonora Riva Sanseverino, Raffaella Riva Sanseverino, Valentina Vaccaro, Ina Macaione and Enrico Anello

Abstract This chapter shows some examples of smart cities. In the chapter, case studies have been divided into geographical categories (Middle East cities; North-European cities; Mediterranean cities and the Asian ones) which, macroscopically, refer to three different types of city and communities especially in relation to different levels of technological innovation and type of human capital, which are key factors in the achievement of a smart development. The chapter is divided into four main paragraphs. The newly built cities, in the Middle East paragraph, are cities where everything has been planned from scratch on white paper to limit emissions and increase the quality of life of citizens. In the paragraphs about the North-European cities and the Mediterranean cities, the cities with strong historic value are described. In this section, many European cities, which have specific features like limited possibility to apply technology, but still an adequate level of development to understand and correctly implement the ICT driven choices are described with reference to the smart city concept. The last paragraph shows some example of "developing city" that often are cities with low awareness about sustainable settlement issues, but with a great economic and social growth. These are, in most cases, eastern cities; they show a great potential and are gradually,

E. Riva Sanseverino (✉) · V. Vaccaro
Dipartimento di Energia, Ingegneria dell'informazione e Modelli maematici (DEIM), University of Palermo, Palermo, Italy
e-mail: eleonora.rivasanseverino@unipa.it

V. Vaccaro
e-mail: valentina.vaccaro.pa@gmail.com

R. Riva Sanseverino
SmartplanningLab, University of Palermo, Palermo, Italy
e-mail: smartplanninglab@unipa.it

I. Macaione · E. Anello
Dipartimento Culture Europee e del Mediterraneo: Architettura, Ambiente, Patrimoni Culturali (DICEM), University of Basilicata, Matera, Italy
e-mail: ina.macaione@unibas.it

E. Anello
e-mail: enrico.anello@unibas.it

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within the world community, trying to create the basis to become leaders of smart cities development.

3.1 Middle East Cities

3.1.1 Masdar City

Founded in 2006, Masdar[1] is a wholly owned subsidiary of the Mubadala development company, formed by the Abu Dhabi government, as one of the means for the realization of the economic vision of the Arab Emirates.

Abu Dhabi has embarked on a ten-years program to move from an economy based on natural resources to one based on knowledge, innovation and export of advanced technologies.

The document called "Abu Dhabi Economic Vision 2030" [1] is driving this transformation. It provides for measures to be taken to transform the Emirate's economy over the next two decades. Abu Dhabi has traditionally played a leading role in world energy markets, as a hydrocarbons producer. Through Masdar, Abu Dhabi is seeking to exploit its own resources and experience in this area to maintain its leadership position in a global energy market that is constantly evolving. The idea is to become an international container for renewable energies and sustainable technologies, in order to balance its already strong position in the field of hydrocarbons [2].

This leadership is demonstrated in many ways. While Abu Dhabi has always been known as a global energy actor, through Masdar, it is demonstrating what a "responsible" producer of oil can do to create a balance between hydrocarbons and renewable energy to address both climate change and energy security.

As is known, more than half the world's population now lives in cities, a percentage which should rise to 70 % by 2030 and cities are responsible for over 70 % of global CO_2 emissions. But only if "sustainability" will be economically feasible, the communities will be able to implement technologies and systems to a large enough scale to make significant progress in this area. That's why Masdar City is committed to building one of the most sustainable cities in the world, as well as an attractive place to live in an economically viable way.

3.1.1.1 Masdar Smart City

Masdar City is a very ambitious project for an oil exporting country; it is the first example of a fully sustainable city.

When in 2007 the government the UAE (United Arab Emirates) announced its intention to build, at less than 20 km from Abu Dhabi, the first "zero emission" city,

[1]Satellite city (under construction) a few kilometers from Abu Dhabi. Inhabitants (potential number) 50,000, Area 640 ha.

many people believed that it was only a vague promise to clean up the Emirates' public image of the whole oil that Abu Dhabi has spreaded over the years. On the contrary, the foundation stone of the first "sustainable satellite city" was laid in 2009.

According to the project the city will host many research centers, training centers and also centers of production in the field of alternative energy, as well as specialized financing and marketing companies in the industry. It may host about 50000 inhabitants and it should be self-sufficient, zero emissions and zero waste. For the realization of the project a capital of 22 billion dollars is being invested. Of this amount, 4 billion are allocated for the construction of city infrastructure [3]. The remaining 18 billion dollars would be financed by direct investments and other financial formulas specifically designed for the construction. The Masdar project was funded by the Abu Dhabi Future Energy Company, a company owned by the Mubadala Development Company.

The project is futuristic and it is no coincidence that it arises precisely in the UAE, the land of petrodollars, where also the World Future Energy Summit takes place, the world's largest event on the issues of renewable energies. The search strategy of the Abu Dhabi Future Energy Company aims to create a major research center for the energy of the future, in order to develop proposals and more efficient systems, driven by the knowledge that soon oil will become a limited and not advantageous source of energy.

Some leading ideas at the base of the project and which account for the different parameters that define the concept of intelligent city are:

- Smart energy. Energy supplied through the use of photovoltaic and wind power plants, as well as obtained from the treatment of the city's waste, with a further recycle and reuse path [4].
- Smart building. Buildings designed to allow near zero energy supply through the installation of renewable systems on the roofs of buildings [1, 5].
- Smart mobility. A transport sector with a totally innovative conception. No longer a clear separation between public and private transport, but a dense and widespread network of micro-metropolitan to semi-individual use (1500 stations around), called Rapid Transit System, which provides easy access anywhere in the city. In addition, these transport units can easily reach the city of Abu Dhabi and the airport. A paradise for pedestrians who can walk quietly in the shady streets [6].
- Smart people. With the start of the Institute of Science and Technology, the city wants to be the first pole of world excellence in research on technologies for efficiency, alternative energies and environmental sustainability.

3.1.1.2 Smart Energy

When the project will be fully completed, Masdar City will cover an area of 640 ha, 600 ha of which will be built.

The following percentage of areas will be addressed to different activities:

- Residential use: 30 %;
- Special Economic activities: 24 %;
- Business: 13 %;
- Service and Transport: 9 %;
- Cultural activity: 8 %;
- University: 6 %.

Given the size and the highly technological content of the project, the construction of the city will take place in 7 different stages. The construction of the city started in 2006, the first phase should be completed in 2016. The first phase involves the construction of a power plant based on photovoltaic panels, able to generate 40000 megawatts of clean energy. Thanks to the energy produced, all the other buildings will then be constructed. Masdar City will be the first city with zero emissions, zero waste, equipped with technologies to harness solar thermal energy, wind energy and its energy needs will be covered without producing pollution or harmful emissions of carbon dioxide [7].

The fact that the project started from scratch shows a series of advantages that should certainly not be neglected: for example, the energy required for cooling of buildings is reduced by regulating the orientation and shape of the buildings. In the streets and in the open areas a balance between sun and shade is created, thus promoting the natural circulation and exploiting the known principles of bioclimatic design. The cooling air is implemented through condensation systems that exploit solar energy directly, instead of a common compressor.

Also water consumption is kept to a minimum, thus reducing the energy required for water desalination; in addition, 80 % of water is recycled through underground collection systems.

As compared to a conventional city of the same size, Masdar City is expected to consume 75 % less energy.

Built on 7 km^2, Masdar city is built to take advantage of the winds for its ventilation through narrow streets lined with green spaces and small water streams. Moreover the city exploits the constant exposure to the sun to be energy-autonomous.

When fully operational, Masdar will have an energy requirement between 200 and 240 MW, which will be produced entirely from renewable sources, 80 % of which just from the sun, through a massive project that involves the construction of a large plant just outside the city and the coverage of all the roofs of buildings with solar panels.

Masdar will avoid emitting about one million tons of CO_2 per year, which, according to the green credit system, can be sold in the coming 21 years, paying back part of their building work costs [8].

Everything will be recycled and reused, from waste (only 2 % will end up in landfill, while the rest will be recycled or used as bio-fuel) to water; 60 % of the latter will be fed back into the circulation system, after being already used and then purified. Even the shopping will be futuristic: one of the currently considered possibilities includes the construction of shops with a touch screen system, through

which anyone can choose and order goods. A service of home deliveries will avoid complications for mobility.

In the city, the use of private cars will be banned. The network of public transport is such that you will not need to walk (along roads designed specifically for pedestrian traffic, so cool and shaded) more than 200 m to find a means of public transport.

Masdar City, in particular, has the ambition to be totally self-sustained by means of renewable sources; the areas surrounding residential areas, therefore, are occupied by wind and photovoltaic generators, research centers and agricultural land for food but also for biomass production [9].

The project is part of the Masdar Initiative, a government program that provides funding to ensure that the country's prosperity does not depend only on oil. The project will provide the country with a dominant position in the field of renewable energies. Everything is designed to reduce the environmental impact and to show new models of sustainable urbanization [10].

3.1.1.3 Smart Building

The Masdar City Headquarter, whose design was entrusted to the study Adrian Smith & Gordon Gill is the starting point for the first city in the world with zero CO_2 emissions and zero waste. The Masdar City Headquarter is the world's first large-scale positive-energy building; it has been designed to produce more energy than what it consumes (buildings 0+).

Masdar city not only represents a kind of sustainable architecture with high values in terms of energy efficiency, but also a building that intends to beat many records: the amount of money for its construction ($300 million); the construction of a building covered by the largest integrated photovoltaic panels surface and the construction of the largest solar cooling and dehumidification system ever built. The latter is designed to consume 70 % less water than another structure of the same size (the 32000 m^2 area consists of three interconnected buildings, which work together to save energy and water and create a shared space) [1].

Masdar City Headquarter represents the perfect integration between architecture and engineering, whose result is a building that exceeds the performance of any other facility of this type in the world.

The team LAboratory for Visionary Architecture (LAVA) was named winner of the Masdar Eco City Center Competition. The competition involved the design of the central square of the city of Masdar designed according to a rigorous implementation plan signed by Foster and Partners.

To the LAVA's project have worked also the Kann Finch Group, Arup and Transsolar. In the intentions of the designers, the Masdar square (which will house a five star hotel, a conference center and a shopping center), will be a world reference in the field of the exploitation of sustainable technologies, a "Oasis of the Future" lively, airy, and interactive, where technology "eco" is made of the functional requirements for service 24 h a day and 365 days a year.

The massive use of systems for continuous monitoring of temperature makes the square a highly efficient and sustainable place.

Giant "sunflowers", equipped with photovoltaic technologies, are scattered throughout the public space. During the day umbrella-facilities are open on the square absorbing heat and sunlight and providing shade and coolness to the underlying space, while at night "petals" of sunflower retire in order to create large "buds" bright gradual heat release.

Lamps with thermal sensors regulate the level of lighting of the space based on the proximity of pedestrians, and can be activated on demand with a mobile phone ringing. Roof gardens, radiating surfaces, ventilation systems that enhance the natural air currents, vapor cooling systems with adaptive cooling for all service functions complete the project which has been drawn up through a comparative evaluation of Estidama[2] parameters (methodology for green buildings design that guided the planning of "Plan Abu Dhabi 2030").

3.1.1.4 Smart People

The Masdar Institute of Science and Technology (MIST) emulates the high standards of the famous American Massachusetts Institute of Technology, MIT. In fact, it will offer high-level master and doctoral degrees as well as graduate programs focused on the science and engineering of advanced energy and sustainable technologies [8].

MIT is working with Masdar to design a sustainable health care system, an academic campus and an advanced scientific research institute. MIST aims to become a high-caliber research center for renewable energy and sustainability, able to attract scientists and researchers from around the world. So it is developing an interdisciplinary collaboration for the realization of infrastructures aimed at promoting the human capital of the region [10, 11].

The aim is also to develop a pool of highly qualified scientists, engineers, managers and technicians able to accelerate the development of sustainable technology and of the different companies in the region and the world. The realization of the solar city of Masdar City is also a political fact. Just before the construction of Masdar City, Abu Dhabi was awarded of being the headquarters of the International Renewable Energy Agency (IRENA), founded in January 2009 in Bonn and then moved to Masdar City in March 2015 [12]. For all these reasons, the Masdar City project is likely to be completed soon, even if the project has already met some difficulties in the course of implementation.

[2]Estidama is a sustainability program for the development of the community of Abu Dhabi contained in the Abu Dhabi 2030 Plan.

3.1.1.5 Smart Mobility

The city of Masdar was conceived as fully sustainable and zero emissions, for this reason also in the context of mobility, Masdar will not employ any means of transport which uses fossil fuel. The use of the car will be extremely limited, and made available only through car sharing.[3] Residents, to move, can count on a compact network of pedestrian paths, bicycle paths, and an innovative and efficient public transport system on rail called "Personal Rapid Transit" (PRT) [13].

In order to achieve the status of "zero emissions city", a local mobility policy which excludes private cars for both residents and visitors was chosen [2]. The city has been built on two levels, a street level for pedestrians and bicycles with shops, schools, housing, and an underground level, where automated and driverless taxis can move. When fully operational the city will host 1500 of these taxis. They can be programmed before departure by entering the destination. It will not be just a door to door transport, but it will work with predetermined stops, within a distance of 150 m from the place to reach. It is an electric robotic mobility system which acts on magnetic rails scattered in the asphalt at speed of 40 km/h. There will not be a driver. Passengers entering the taxi at the stop will type on a screen the destination, will pay the run and will be transported to his destination. There will be a centralized control in constant communication with the taxi that will choose the shortest path to the destination. Eighty-seven stops compose the entire paths the taxis can tread.

They can run through the city center and the neuralgic places (airport, train station, MIT headquarters in Masdar). For the future, however, one can imagine an even more widespread service. Masdar people will move a lot, if the forecasts to have about 1500 companies, in addition to residents, will be correct.

The cost is easily determined as a PRT project costs around 10–15 million per kilometer, as a tram line. A metro line underground dug costs around 70–80 million per kilometer. The inventor of this PRT system is an Italian, named Luca Guala, who works in an engineering company (Systematica) which has participated in the project as a consultant in the field of transport, addressing all issues related to the analysis, studies and strategies to define the internal mobility of Masdar.

The roads are designed to encourage walking and cycling. Masdar City is protected by real walls that will prevent access to any polluting means. For commuters, however, outside the walls, specific cars parkings are built to leave the cars.

The work done by Systematica, has contributed significantly to the creation of a "zero-emissions city" fully consistent with the overall project done by a multidisciplinary team. Studies propose and promote modern technologies and strategies for mobility that are implemented for the first time ever as part of the Masdar project [14].

[3]It is a service that allows the use of a car, owned by the car sharing company, for a limited time through a booking service available on smart phones or on line services.

The Emirates are also at the forefront in the future design of social life in close connection with the environment. The will and the need to focus on environmental protection to free from oil-based economic dependence make the Gulf country one of the most advanced laboratories in the Green sector.

3.2 North-European Cities

The northern European cities have been for long engaged in the field of sustainability, economy with low environmental impact, high quality of life and livability of urban spaces. Among these, in the most recent European rankings of smart cities, cities like Amsterdam are in evidence as the *forerunners of smart cities*, as they entered in the forefront positions in the first rankings done by international research centers.[4]

At the top of the ranking, even today, there are the northern Europe cities. This is confirmed by a recent ranking developed by Boyd Cohen,[5] the *Smart Cities Wheel* [15]. The ranking of Cohen was compiled through a holistic framework that, taking a cue from the first European ranking of Smart City drafted in 2007 by the University of Vienna [16], considers all the key components of what composes an intelligent city (smart people, economy, mobility, environment, governance, living) and describes these items through three key drivers for each sector. The tool has been defined after conducting extensive research on the existing ranking tools and on systems to measure the smartness of cities in the world. It was also the driver for a lot of smart city initiatives in Argentina, Chile, Iceland and the United States. According to the ranking, the ten most smart cities in Europe belong to the north Europe, Copenhagen, Stockholm, Amsterdam are the first three.

3.2.1 Amsterdam

Amsterdam,[6] the capital and largest city of the Netherlands, is situated in the province of North Holland. The municipality has about 800000 residents of more than 170 nationalities, while the population residing in the metropolitan area is

[4]One of the first specific ranking tools for European Smart City of medium size was drafted in 2007 by researchers at the Technical University of Vienna in cooperation with the University of Ljubljana and the Delft University of Technology .

[5]International expert on urban sustainability and climate change, writer, researcher, professor, consultant and climate strategist, he helps communities build sustainable places, focusing on climate capitalism (which shows how communities, cities, countries and companies around the world are profiting from the transition to a low carbon economy) and on resilient cities.

[6]Inhabitants 810,084 (2013); Area: 219.33 km^2; Density 3699/km^2 (town and city center).

approximately 1450000 people. The city of Amsterdam is surrounded by four main canals forming a half-ring around it.

The area at the center of the city, surrounded by thirteenth century canals, is a prestigious site and since 2010 has been declared a world heritage site. According to the United Nations (UN), the network of canals which develops within the city is one of the "universal value" sites to be preserved.

From the orographic point of view, the Netherlands territory has almost no mountains (about 50 % of the surface is less than a meter below the sea level). The struggle to wrest the land to the seas and rivers is one of the recurring themes of the history and geography of the Dutch country. Much of the territory consists of polders, land reclaimed from the sea or from lagoons and coastal marshes.

The climate of the Netherlands is temperate oceanic, the winters are not too cold, in fact, the average temperature in January is a few degrees above zero (7 °C), although frosts are frequent, the summer is cool and rainy with average temperatures in July slightly below 29 °C; the particular shape of the territory finally also favors the formation of fogs [17].

The city center originates from a fishing village located near a dam on the Amstel River. On this inhospitable expanse of marshes, the original nucleus of the village grew thanks to hydraulic engineering, which allowed in the centuries to create land for building. The subsequent development of the city around the ancient center has been characterized by the practice to fill or empty the canals. In fact along time, there were those who supported the idea of having new land available for the livability and transit and those who said that Amsterdam should remain a city of canals and then the development should follow the path of the existing canals. It was this second idea to prevail and to define the shape of the city in the first urban planning tool of the city of Amsterdam (Kalf floor, 1875 [18]), whose general outlines envisaged the radio centric development around the old city, the construction of roads in accordance with the existing tracks of irrigation canals and the identification of an orthogonal grid, which regulates the new settlements. From the Kalf plane, passing through the plan[7] of expansion of the city towards the south, in 1935 was defined the master plan of the city which still is in force.

Below are the guidelines of the urban plan of Amsterdam:

- limit the urban expansion to reduce the consumption of the available state land;
- pursue the effective integration of residential and working areas, reducing the daily commuting and discarding satellite towns solutions;
- plan the urban expansion, dividing it by functions in continuity with what is existing;

[7]In 1928, the technical municipal office was created in Amsterdam. Its coordination was given to Cornelius Van Eesteren by whom rationalistic urban planning was invented. The plan of 1928 (active since 1935 and in full implementation till 1965 without any variation) is implemented on the track of southward, designed in 1902 by H.P. Berlage but that also represents the conceptual overcoming.

- promote a growth model for neighborhoods with strong identity and that can be expanded through subsequent phases, this is an indispensable model for the presence of green passages, which prevents the creation of a continuum from the existing city;
- plan the "fan-shaped" expansion from west to east.

The steps above show that the limits imposed by the original tissue have become characteristic and inspiring for an efficient and "smart" planning of the city.

3.2.1.1 Amsterdam Smart City

The Amsterdam Smart City program, launched in 2009, is a good example of an initiative organized and financed by a mix of public and private funds. In the organizational structure of the program, the Public Administration is a partner in governance and operation. Along with private groups (Alliander, KPN, etc.), the city of Amsterdam has been at the forefront to support the Amsterdam Smart City program, ASC, not only in economic terms, but also encouraging collaborations and results orientation.

The starting point of collaboration of the Amsterdam Smart City program is the fact that the funding partners are engaged in long-term objectives, related to the problems the metropolitan area of Amsterdam is currently facing and the opportunities that are and will be made available.

A deployment of new infrastructures was started, enabling all kinds of new products and services: intelligent energy networks, fiber to the home and open data. In other words: power, connectivity, and data. These basic infrastructures, have allowed other companies to develop and implement innovation, bringing energy savings, more efficient health care, less traffic, and greater availability of services. ASC is developing the program on behalf of all founding partners, with two main objectives which are: to facilitate the bottom-up innovation, and bring together the investments that will be incurred in the coming years. These objectives have produced more than 20 pilot projects in the first 3 years and a collaboration with 72 partners. The same partners have tested numerous products and services, which were then brought to market.

The ASC model is very simple: in the center there are three founding partners, all of which have long-term economic interests concerning infrastructures to be given in use, and joint ambition to solve societal problems. Through ASC Program they shall cooperate with other subjects: strategic partners in certain thematic domains (companies like Philips, Cisco, IBM, Accenture) and small and medium enterprises at the individual project level. In this way, there is a differentiation between the partners with long-term goals (partners in the field of infrastructure), with medium-term goals (strategic partners), and short-term goals. The involvement of public administration is essential; in fact, it creates confidence in the achievement of objectives, ensuring open data, long-term commitment, targeted policies and leadership.

Even today Amsterdam Smart City is a collaborative plan that continues to bring collaboration between residents, government and local production bodies, in order to implement a high level of energy savings [19]. Energy end-use efficiency, use of renewable energy, smart grids and recharging facilities for electric vehicles are some of the elements that have been composed to achieve a single final goal that, according to the administration, will quantify in a reduction of 40 % of CO_2 emissions by 2025, compared to 1990 levels and of 75 % by 2040 [20].

The plan continues to develop through various projects covering the following areas: mobility, quality of life (health, safety and tourist attraction), care of the social and human capital, resource efficient, intelligent infrastructures and open data.

To implement the project, articulated in substantive but also symbolic interventions, the city has relied on some local companies, most notably Accenture, which deals with intelligent networks. Accenture supported the Amsterdam Innovation Motor and Liander[8] (which was given the task of implementing projects in the field of mobility), in the transformation of the Dutch capital of the first European urban center with high energy savings, thus becoming a wholly-smart city [21].

The initiative has shown that it is necessary to integrate smart meters and smart grids but also bring profound changes in the way people live the city. The first interventions in this direction date back to June 2009 when the public space Utrechtsestraat (central street of the city of Amsterdam), thanks to the cooperation of local entrepreneurs, has begun to develop into a sustainable commercial street, through a project that included interventions for a reduction of CO_2 emissions by 57 % as compared to previously recorded data.

The project provided for the following interventions:

- bus stops created with recycled material;
- led based public lighting powered by solar panels on the roof of the stops;
- compactor bins for separate collection of waste powered by solar generators (these devices press the waste and allow a reduction in weekly cycles of waste collection as well as the volume needed for their storage in special centers).

The continued success of the Amsterdam Smart City project is the definition of a strategic plan, marked by progressive stages which is fundamental for the implementation of the objectives and individual measures [22].

The following are, by subject area, some of the projects already implemented and that are being implemented.

[8]Liander is a Dutch company active in the distribution of electricity and natural gas in the Netherlands.

3.2.1.2 Smart Energy

The project actions in the context of energy are central in the city strategy. In fact, Amsterdam in this area, is a benchmark for all other European cities since 2009, placing itself as an urban laboratory for energy and, as it can be seen from the Table 3.1, with increasingly stringent targets.

As it can be noted, the largest share refers to the energy produced from waste [23]. The electricity power plan from waste in Amsterdam, which is owned by the municipal corporation AEB [24], produces 560 GWh per year of electricity and 548000 GJ of heat. The Amsterdam tram and underground, the town hall and the public lighting system are all powered by the waste of the city. In addition, the excess heat generated during combustion is used to provide district heating and hot water to dwellings and enterprises. In the near future, the heat network will connect more families (about 30000–50000), thus reducing the need for fossil fuel for the boilers in the private dwellings.

The incinerator also produces 11000000 m^3 of biogas from sewage sludge. In fact, thanks to a collaboration between the AEB company and Waternet (company in charge of providing drinking water to the city and to keep the right level in the complex Dutch groundwater system), a new purification plant of sewage sludge next to the AEB's plant has been recently built. The project allows using the sludge, a byproduct of water purification, as biomass to produce electricity from renewable sources through the incinerator. The agreement implies that AEB provides energy and heat for the purification plant [25].

This suggests how the partnership between different actors, public and private, is one of the keys to the success of Amsterdam as smart city.

About the electricity grid, the most significant work of the Amsterdam Smart City Project is the implementation of a smart grid. In fact, all the city should soon be connected to an intelligent network, which will allow, through monitoring and control systems installed in each dwelling (energy boxes), to manage the energy consumptions more efficiently. Currently there is one main project about smart grids deployment 'City-ZEN' (City-Zero carbon ENergy). Showcase ambitious pilot demonstration projects related to energy efficient retrofitting, innovative district heating and cooling networks and smart grids at the level of districts are going to be implemented, with the interesting background about the fact that different infrastructures are today mixing, supplementing and even substituting for each

Table 3.1 Estimates of future production of electricity from renewable sources in Amsterdam. Data from [22]

Estimation of energy production (GWh/y)	2020	2025	2040
Solar energy	160	300	1000
Wind energy	380	540	740
Energy from waste	560	560	560
Total	1100	1400	2300
% of the total private consumption	23	29	47

other. Besides *this does not happen just for domestic heat system and gas grids, but also for electricity, fuels, sewage, drinking water, ICT and solid waste.*

The intelligent network aims to optimize consumption and receive more and more green energy produced by small plants scattered throughout the city. In fact, solar panels are continuously installed on the buildings of the city center as well as micro wind systems, going towards a distributed power generation system. Regarding the production of green energy, it must be said that the project started in 2009 by the installation of over 3000 solar photovoltaic panels on the roofs of the buildings of one of the productive districts of Amsterdam (Zuidas district [26]). It is estimated that the 3000 panels, having a production capacity of 0.5 MWh per year, are enough to cover the energy used by 30000 employees in the district offices.

The future modernization of urban infrastructures also allows families to sell the energy generated by small wind turbines or photovoltaic panels. In Amsterdam, for example, groups of citizens gathered in green cooperatives to propose alternative solutions to personally manage the energy market, producing energy and selling it, having a substantial saving of the energy bills.

With its 400000 inhabitants, Amsterdam, like most large European cities, host dwellings that are responsible for more than one third of total CO_2 emissions. From the forecasts it can be seen how, by applying energy-saving technologies in dwellings, the emissions can be considerably cut down; to that end, it was important to develop in users (citizens) an awareness about the importance of energy efficiency and of issues related to it. This is probably the second cornerstone of the success of the smart city in Amsterdam.

To achieve the ambitious goal to reduce CO_2 emissions, in fact, the Municipality adopted an energy strategy, which has primarily involved citizens. The three basic principles, on which it was necessary to work to achieve the objectives, are: energy saving, sustainable generation and waste heat re-use. As mentioned, it is necessary an integrated approach to the energy issue, and citizens, in this new scenario, are the main actors of urban transformation.

The "West Orange" [27, 28] project is one of the first projects carried out by the city with the participation of citizens. The project founds itself on the assumption that citizens are not naturally inclined and able to rationally control the use of energy. In daily life, little or no attention is paid to the energy class of appliances and their consumption. For this purpose, the project has implemented intelligent technologies with the aim of changing the awareness on energy consumption.

Five hundred families, in the first instance, have tried an innovative energy management system based on the use of smart meters, leading to a saving of 14 % of energy consumed per family and an equivalent CO_2 emission reduction. The goal of the project is to broaden the users served by these devices and connect up to 200000 dwellings with smart meters.

Another pilot project provides access to microcredit for 728 families, which can finance the purchase of home *appliances that are remotely controllable and high-energy class*, paying the mortgage payments thanks to the savings of energy

consumption in the bill due the use of such appliances. These innovations have an estimated cost of around 350 euros per household.

In the smart city vision, a growing number of private producers of green energy, such as Onze Amsterdam Noord Energie, are rising [29]. The project of this company, aims to involve citizens, of the North of Amsterdam and of the Waterland region, in the production of green energy through the installation of wind turbines in these areas: the aim is to be able to cover up to 20 % of the energy needs of the Northern area families.

The initiative allows citizens to become cooperative members. They give their land to the company and so they either become owners of these small wind farms, or they purchase the shares of the installed mills. Thanks to this project, in Amsterdam North, the residents produce the electricity needed to power more than 8000 households with seven windmills. The initiative also allows them to be active in the management of the co-operative.

The city also has introduced a subsidy program to encourage residents to the construction of green roofs and walls on their properties [22].

Finally, in the New West district there are about 40000 domestic users, about 10000 of which are powered by the new smart grid Alliander. The New West neighborhood has also a high penetration of smart meters and solar installations.

The New West district was chosen for the realization of the first smart grids project in the Netherlands. In this way, the number of smart meters, monitoring and control devices is increased, thus producing a reduction in the number and duration of outages and a greater possibility for customers to participate in the sustainable energy generation.

Another important element driving the successful collaboration between citizens, companies and administration is the transparency regarding the projects to be pursued. All experiences and projects are propagated through a portal (ASC) which is always updated: recently (2014) the French Prime Minister F. Hollande has signed a cooperation project between the two municipalities of Amsterdam and Lyon, with the distribution companies electrical reference and universities (Technical university of Grenoble).

3.2.1.3 Smart Mobility

As we know, the transport system is one of the main responsible of air pollution in large cities. In Amsterdam, one third of all CO_2 emissions come from the maritime transport system. The port of Amsterdam, for cruise ships and cargo ships, is located near the city center. The energy supply system of the moored boats, as for most of the touristic European ports until a few years ago, relied on self-production of energy through diesel generators on board.

The project “Ship to Grid” includes the installation of 73 electricity distribution units from renewable sources on the banks of the river Ij with a total of 300 connections [30]. The moored boats can switch off their generators allowing the reducing of CO_2 emissions of the city.

The first phase of the project is addressed to touristic boats and those of freight transport, the project is extending to all the other boats.

The shore power is available through connections that use a pay-by-telephone system. With a single telephone call, the captain is able to activate a connection with the shore power station by entering his personal code. The connection is deactivated by logging off or plugging out at the connection point and the amount of money owed will automatically be transferred from the vessels account. The CO_2 emissions from the used renewable energy are minimal.

Regarding the mobility on the roads, the city of Amsterdam has decided to launch a program to eliminate the internal combustion engines within 30 years. The environment councilor Marijke Vos has outlined a project which provides 200000 electric vehicles on the road by 2040. The city also plans to install a network of charging stations. The first goal is to have 10000 electric vehicles in circulation by 2015, with the expectation that gradually all of the city's road mobility can be zero emission.

Incentives will also be introduced to purchase electric vehicles, the owners will have the priority to obtain parking permits for residents [31]. In Amsterdam, currently the waiting list to get a permit for residents is 5 years and the parking lots in the center cost up to 5€ per hour. According to the plan of the councilor Vos, even the touristic boats, that travel the canals of the *Venice of the North*, will have to convert to electric engines. Moreover, freight transport in the city will be changed. Infact, only one tram City cargo can carry the equivalent of four trucks goods each carrying 7.5 tons. In total, about 50 trams and 600 electric vehicles will be operational. They can work between 7.00 and 23.00, instead of focusing only on the morning timeslot, as provided for by the city's regulations for transporting goods on roads.

The benefits will be seen at many levels: it is expected that the project "City Cargo" [32] halve the presence of trucks and vans in the city, from the current 5000 to 2500 per day; in this way the carbon dioxide emissions are reduced of 16 %. Halve commercial vehicles in the city also means to decongest and make safer road circulation and reduce noise pollution. The City Cargo project will also result, according to the organizers, in a yearly savings of 125 million euro for the city of Amsterdam and in the creation of about 1200 jobs, involving the activities of storage platforms and the distribution network of trams and electric vehicles.

It is common to think of Amsterdam as the capital of the bicycle, and it is also in this field that the city is acting with sustainable projects. In fact, Amsterdam offers services like Mac Bike, bike sharing with bicycle storage sidings (bike sharing was born in Holland in 1965 and was then exported all over the world), or bike rental which allows to have a rental bike also for several days.

It must also be considered that the Netherlands in the sixties had conceived the Provo's White projects against consumerism and for ecology; they proposed to replace the traffic of cars with bikes, thanks to a public and free distribution of bikes owned by the Municipality, painted in white [21].

Now more than seventy thousand bikes go around in the city of Amsterdam and the *bike-power* made it dangerous for the impolite tourists to casually cross a bike path.

3.2.1.4 Smart Building

Within a smart vision of the city, one of the most complex issues is that of designing energy efficiency measures on historical or constrained buildings, largely present in urban centers of European cities. The canals of Amsterdam, which were inserted in 2010 in the UNESCO World Cultural Heritage, are an example of how big is this problem. Most of the seventeenth century buildings in the city is located in the Canals area, and this is the reason why this is the most populated area and also the most visited by tourists. In Amsterdam, like in most large cities, 34 % of CO_2 emissions is linked to the building sector and in the absence of redevelopment of the historic buildings, the competent authorities indicated that this percentage would increase to 36 % by 2025. It then necessitated some sustainable measures targeted in the historic downtown area experimenting new technologies which respect the historical value and fruition of buildings. An example is the "De Groene Bocht", a seventeenth century building along the canal in the center of Amsterdam used for offices, in which a large fuel cell technology[9] plant was installed for the first time in the Netherlands.

The plant, based on the unit BlueGen [33], was developed by Ceramic Fuel Cells (which is a state of the art German factory in this area). The system installed in the building produces most of the electricity that the building needs, on site. In addition, the recovered heat is used for domestic hot water, bringing the total efficiency above 85 %. Considering that the electrical efficiency of this unit is greater than any other technology until now experienced, the Municipality plans to expand the use of this system to a growing number of buildings in the city center.

Simpler and more immediate are the energy efficiency measures in the modern buildings, that, if they were not directly designed and built as sustainable architecture samples, such as the Nemo building by Renzo Piano, located in the port area, can adapt more simply to the technology progress in the energy-saving field.

In this sense, one of the first actions taken was an intervention on the prestigious ITO Tower, office building located in the Amsterdam Zuidas area. The building is sustainable thanks to the use of the latest monitoring technologies and intelligent control systems. The office are, 38000 m^2, has been subjected to a detailed analysis about energy consumptions and CO_2 emissions.

Subsequently, through an energy management system (mini grid), thanks to a network of sensors supporting a building automation system, the following functions have been implemented: control of lighting, heating and cooling regulation, building security; most of these actions resulting in lower fuel consumption.

[9]Fuel Cells (FC) are considered by the entire scientific community an energy conversion technology with low environmental impact and high efficiency. The use of such systems also promises substantial economic benefits due to the high conversion efficiency. Research in the field, started 20 years ago, is constantly changing especially for plants of large size, for which you do not have a clear reading of the useful life of the system and has not yet reached a just technological maturity that allows the widespread dissemination of this experimentally. As of today there are already many companies that promote applications especially for small plants.

Instead, within the public spaces of the city, such as parks, gardens and along the main streets, it is expected the inclusion of Sun Spot; these are working outdoors places where citizens can use the electricity produced by solar panels installed on the roofs in the same areas, and use the public wifi network. The aim of the project is to direct citizens to enjoy sustainably those outdoor spaces that the city offers. Among the many projects to raise awareness on energy saving that cities and local authorities continuously promote, the Smart School project has involved ten primary schools. The project was carried out through a competition that has rewarded the school that in 1 year obtained the highest energy savings, also developing a student's web portal and specific lessons on this topic.

3.2.1.5 Sustainable Neighborhoods: Zuidas and GWL

Arriving in the historical center of Amsterdam, any tourist can recognize the main elements that characterize the city: gothic architecture, cycle paths, canals and clean public transport.

On the border between the old and the new, to the south, there is Zuidas, a district commissioned in 1998 by the City of Amsterdam to De Architekten CIE (professional studio that designed the master plan). As the name suggests in Dutch the district has an ideal strategic location in close proximity to Schiphol Airport.

Zuidas, whose construction has already begun, will reach its full potential by 2040 (in line with the Zuidas Vision Document 2009, [34]). The buildings in Zuidas host offices and homes. It will be a highly populated district of 2.5 km^2, which continuously grows in height; the skyscrapers in fact, are a key feature of the district. The decision to build in height as well as being in accordance with the tradition of the city's buildings, linked to savings of building land, refers to an architect teaching Les Corbusier "building space by removing the sky, means to give it to the ground"; Zuidas is built in height so that large green areas and public spaces around the skyscrapers may arise [19, 35, 36].

The other major point of strength of the project was to channelize the traffic to decrease the polluting emissions from transportation, therefore the streets, right here is the biggest surprise, become the hidden heart of the district. The main transport infrastructures are in fact buried. At completion, there will be seven underground tunnels, 1.2 km of trails, five of these dedicated to the railway and metro network, with the aim of greatly strengthening the public transport and convey there about 50 % of trips, while more than 20 %, as usual for Dutch cities, will be conveyed on the bike paths.

An example of harmonic development of technology and environmental protection is the Vivaldi Tower of Norman Foster & Partners. A single building with two towers, 87 m high and 12 m wide, 24 floors designed in every detail: the two blocks are not aligned to allow light to filter further. The north-oriented facade is completely in glass, but those to the east, west and south are only 30 % to avoid an excessive overheating due to solar gains.

A green roof once again reminds Le Corbusier [36] and its roof-terrace, used as a public space, as well as give greater thermal insulation. Rain water is not wasted, but collected on-site and also purified naturally through a biotype consisting of grass, reeds and water lilies. The excess of water eventually will feed the channel crossing.

With the realization of the Zuidas district, Amsterdam claims that it will become one of the ten most sustainable cities in Europe by 2040. The neighborhood is growing phase-by-phase and, once completed, it will accommodate about 20000 residents and 50000 workers. By 2025 it is expected to achieve a 60 % reduction in CO_2 emissions, with a contribution of renewable energies of at least 20 % of total consumption, and with very advanced energy standards for buildings.

In the Netherlands, since more than a decade sustainable development criteria are applied to the field of planning and building, and there are many sustainable projects, such as the recovery of old brownfield sites, which have made the city greener and livable.

Another example is the GWL district [37] arising from the recovery of an area previously occupied by a company, which supplied water to the city of Amsterdam. Its implementation is linked to an urban renewal program that has affected the entire city. The preparation of the master plan was carried out by Kees Christianse and West, who has worked on the design of the landscape and open spaces, which take on a great importance in the project. The design of individual buildings was, however, entrusted to different architects who worked in a perspective of sustainable architecture.

A large part of the materials resulting from the demolition of existing buildings has been recovered to build the new district, and, where possible, it was decided to retain the materials and structures, so as to minimize construction waste from entering landfills, as well as the movements of the means of transport to and from the construction site. The new district consists of 600 apartments distributed over an area of 6 ha. Within the area there are new buildings, which act as a protective barrier from the prevailing winds and protection from noise and pollution of the nearby industrial area, and existing buildings reconverted into shops and homes.

The peculiarity of the district is that, although extended, it is designed so as to be a car-free area. The choice, not only for environmental reasons, also derives from economic considerations: the high environmental quality, in fact, makes it the most attractive district for the wealthiest families that otherwise would not be transferred to a region formerly known for being among the poorest district of the city. At the west end of the neighborhood about 110 parking spaces have been provided for residents, sufficient for just 20 % of them to which, among other things, it is forbidden to park in the surrounding neighborhoods. This fact prompted 57 % of the inhabitants in give up owning a car.

This was facilitated by the excellent public transport network and the strategic location of the neighborhood, which is just 2.5 km from the central station. In GWL there is an average of 4 bikes every three inhabitants, 39 % of residents have a subscription to public transport and 10 % of them use the car sharing program.

3.2.1.6 Ongoing Projects and Recent Innovations

This paragraph briefly summarizes the most important innovations in the various areas that have been recorded in recent months in Amsterdam on the topic of intelligent cities.

New "green offers"

In November 2013, seven new green projects, including a Green Deal "Smart Energy Cities" [38] and Green Deal Fair Meter, were signed.

Soon through these projects in Amsterdam will be launched a number of partnership projects for converting most of the urban building stock of the town to intelligent buildings (it is expected to apply by 2019 the concept of intelligent building to 100000 units).

The Green Deal "Smart Energy Cities", for example, is an agreement that aims to develop smart technologies and concepts in the field of renewable energy and using this energy transition, but also to promote employment. The Green Deal was signed, among others, by the Ministry and the municipalities of Amsterdam, Arnhem, Eindhoven, Groningen and Enschede.

East Coast Electric

During 2013, an agreement called East Coast Electric program was signed between Microgrids US experts and EV dutch producers. It is a public-private partnership of 2 years in which 14 companies, start-ups, universities, research centers and organizations work together to improve the Dutch technology in the field of electric vehicles and microgrids. Carolien Gehrels—Deputy Mayor of Amsterdam said about this program: "A program like East Coast Electric makes sure that companies in the U.S. look at our region as a hotbed of innovation, where they can do a pilot, launch a product or establish themselves in the Netherlands as a gateway to the European market" [39].

The family becomes a champion in energy savings

Waag Society—institute for art, science and technology—is a pioneer in the field of digital media in Amsterdam. Over the past 22 years, the foundation has developed into an institution of international level, a platform for artistic research and experimentation, and has become both a catalyst for events and a breeding ground for cultural and social innovation [40].

Waag Society is always active in the social context. Waag Society, now, is looking for all ways to test and experience the energy approach of Dutch households. For this reason, the company continues to offer workshops and develop ideas with the aim of encouraging the participation and knowledge of the citizens to innovative projects.

Open data platform: Amsterdam, Barcelona and San Francisco

Open data are a primary importance resource for smart municipalities. It exhumes valuable information from file drawers and databases and puts it to work for the benefit of people and their savings. It improves the transparency and openness of governments. Ger Baron, IT program and cluster manager at Amsterdam's Economic Board said in 2013: "In Amsterdam we have been working very intensively on open data for the last few years. Now it is time for the next step, a step that we want to take with a couple of the leading cities in the world and our ambition is to help set a standard for smart city collaboration" [41]. For this reason the three capital cities, Amsterdam, Barcelona and San Francisco, have signed an agreement (2013) for the creation of a digital platform to exchange useful information and data for the innovation of urban processes.

City-zen

It is a project that sees a collaboration between citizens of Nieuw-West district of Amsterdam and the Eco Cité de Grenoble in order to share and think about innovative ideas. Within this project the Amsterdam district focuses on buildings. In the coming years, 30 million euros will be invested in innovative projects for buildings, especially in Nieuw West district. The City-Zen project [42] that sees the cooperation of the municipality and of various companies (Waternet Liander, AEB, Ymere) will study solutions such as smart grids and smart meters; district heating; testing of products for energy saving; raising awareness of young on energy saving through the definition of a video game to score (The Serius Game). The latter, by reading data from smart meters, allows them to simulate the savings in the bill generated by virtuous behaviors. Given the success that the games that reproduce virtual reality have on young users (just as the SimCity game phenomenon), it is assumed that this project will have a fundamental resonance in a substantial part of home users.

Flexible street lighting

In the first months of 2013 it has kicked off the project carried out by the flexible lighting Alliander che which put at the disposal of an "Open Smart Grid Platform" that allows to monitor and manage all types of public lighting devices remotely. Currently the system is being tested on 50 poles of the municipality.

3.2.2 Stockholm

The city[10] is situated along the east coast of Sweden, developing over fourteen islands that emerge where Lake Mälaren meets the Baltic Sea. The city center is located potentially in the water, in the Riddarfjärden Bay and the old town is

[10]Inhabitants 843.139 (2010 census); Surface 216 km^2, Density 3.9 inhabitants/km^2.

represented by Gamla Stan. Precisely because of these characteristics, the city has been dubbed the "Venice of the North".

The climate in Stockholm is quite varied from season to season because of its northern latitude. Winters are cold and snowy mainly due to the weak enough sunlight just before the middle of November until the end of January, while the summers are mild and rainy, but also with anticyclonic periods. In the winter the more or less intense frosts are daily and generally the temperature is just below freezing even in the middle of the day. The hottest months are June and July, during which the maximum temperature rarely exceeds 30 °C.

Stockholm is Sweden's most densely inhabited city, in fact about 20 % of the Swedish population lives in it.

Geographically, Stockholm has changed along time. During the nineteenth century, it basically consisted of the downtown area of about 35 km^2 corresponding to one fifth of the area currently occupied by the Swedish capital. In the following century, it absorbed many other towns and the currently established city limits were designed in 1971, with the exception of Hansta, which was acquired in 1982 by the municipality of Sollentuna and turned into a natural reserve. In 2004, out of a population of 765044, 370482 inhabitants are male and 394562 female. The average age is 39.8 years, and 40.5 % are aged between 20 and 44 years.

The metropolitan area of Stockholm, Greater Stockholm (Storstockholm), or Stockholm County, is a conurbation that includes 26 municipalities (including capital). It covers 6519 square km with a density of 307 inhab/kmq.

3.2.2.1 Stockholm Smart City

Stockholm has put into practice in a few years a number of actions that will allow to reach the ambitious project to be fossil fuels free in 2050 [43].

Stockholm is a "green city" rich in parks and open spaces to cross and to spend time: 90 % of the population live less than 300 m far from a green area. This choice was further enhanced in the new city plan, which already from the nickname shows that it is a "Walkable" city [44]. This allows an improvement in the quality of life by recreational activities, water purification and noise reduction as well as biodiversity and ecology support.

Stockholm has already reduced CO_2 emissions by 25 % compared to 1990. Currently they are less than 4 tons per capita, half the Swedish average. 69 % of households have access to district heating, in which the share of renewable energy is close to 70 %. The biogas is produced in plants for the treatment of waste water through the digestion of organic sludge. In the eco-district of Hammarby, the waste water from a single house produces sufficient biogas to cover the gas demand for cooking use. Most biogas is currently used as fuel in cars and environmentally friendly bus. The collection of food waste for biogas production has increased from 4500 to 18000 tons between 2008 and 2012. The city has an excellent system for the treatment of waste and uses innovative production methods as an underground transport system of municipal solid waste which works by suction. 25 % of the

waste produced by the Stockholm is recycled, 73.5 % is recovered for use (by incineration) district heating plant and 1.5 % is biologically treated [45, 46].

3.2.2.2 Smart Mobility

Stockholm has a strong mobility infrastructure system: subway, suburban trains and trams. Public transport is very efficient and very used, the capillary networks are integrated and, 90 % of the population live less than 300 m from a bus stop, on average 60 % of commuters uses public transport and, during rush hours, the same share reaches 80 %. All city buses are powered by bio-fuels and all subways and trains are powered by electricity produced from renewable sources.

There are many cyclists of all ages, no scooters and, in the last 15 years, car use has significantly decreased. The city government is committed to building new infrastructures and to reduce the impact of transport. Among the initiatives, for example, there is the construction of the Citybana, a gallery that will allow suburban trains to cross the historical center and no longer travel on the central bridge (Centralbron) which, connecting the north and the south of Stockholm, is one of the main traffic arteries of the city center.

The company that manages all public transport, responding to the dictates of the municipal administration, follows a strict sustainability strategy: 400 vehicles are fueled by ethanol and 200 by biogas; the goal is to reach 2025 without public transport powered by energy derived from oil. Today half of the buses use alternative energy sources.

The tariff system for accessing the city put in place by the Administration has reduced the private use of vehicles by 20 % in 5 years, and incentives to car sharing and scrapping have recently increased this percentage. Thanks to these initiatives, noise pollution and air quality are improved and greenhouse gas emissions are fallen by 14 %. Ethanol was chosen as an alternative to gasoline and diesel fuel and, according to an established habit, it is the city government to set an example. In fact, already in 2008, all public cars were supplied with clean energy.

The challenge for the future is the spread of the biogas produced with urban waste, through which CO_2 emissions could be reduced by 85 %. For this purpose the Bromma waste treatment plant has been expanded and is now able to produce 1.5 million liters of biogas each year that can be used for cars, for heating and for domestic use.

On the housing front, there are many actions for sustainability, with energy reclamation and strict saving strategies, starting again from public buildings.

Large urban transformations also become a springboard for experimentation and environmental policies, such as Hammarby Sjöstad and, soon, the Royal Seaport, a great opportunity to redevelop the suburbs and to make a piece of the city smarter.

3.2.2.3 Sustainable District: The Hammarby Sjöstad District and the Royal Seaport

The eco-district Hammarby Sjöstad (HS, one of the southern district of Stockholm), is located at a few minutes from the historical center and since a few years ago it hosted an industrial area. Sjöstad litterally meand "city on water" and owes the name not only to the fact of being alog the lake Malaren, but also because water is the main energy source.

Located near the historic center, the Hammarby Sjöstad district (HS) is one of the southern district of Stockholm; it represents the first application of the plan "Vision 2030" [47], which contributed to the victory of the European Green Capital Award, awarded in Stockholm in 2010.

The district has a fairly high density, 22000 residents and 10000 employees over 200 ha, where spaces are bright, it seems there are no cars, with a modern metro-tramway, tree-lined boulevards, pedestrian plazas traveled by bicycle. Finally, water, which is present everywhere, is a fundamental component of the project [48].

HS is a residential construction project: the district is also self-sufficient in terms of energy thanks to the use of clean and renewable sources: biomass, biogas, solar, hydrogen and a hydroelectric plants provide 8000 apartments of nearly all energy needs [49]. The history of HS begins in the early nineties when Stockholm decides to run to host the Olympic games in 2004. A team of architects and engineers identifies the former industrial area of Hammarby the ideal space for the construction of the Olympic Village. Already in the original design, the dominant feature is the idea of eco-friendly architecture. Stockholm did not get the Olympic Games, but the Hammarby project was not shelved, rather it was upgraded and converted to residential use [49].

The strategic elements of the project are those that are not visible, especially in the areas that affect mobility and waste management.

A light rail will connect the district to the city center, while a variant of the road join the new Stockholm's outer ring road. An impressive library, a large cultural center, kindergartens and schools will make Hammarby Sjöstad a small ideal city, barrier-free and decorated with sculptures and fountains of young Scandinavian artists. All domestic waste water flows are channelized into huge tanks in the basement where, through appropriate treatment, slurry forms biogas that is immediately used in the kitchens of such buildings, while the urban solid residues are then collected and processed into fertilizer.

Half of the apartments in Hammarby Sjöstad are equipped with this type of gas cooking appliances. Even the waste, although separated, are collected in underground tanks emptied by huge vacuums and sent for recycling (thus avoiding the unsightly bins and minimizing the costs of collection). Non-recyclable wastes are transported to the local incinerator. Their combustion produces heat enough to cover 47 % of domestic heating. The remaining 50 % comes from combustion of organic oil (16 %) and by the energy produced from the waste water (34 %). The electric energy comes instead from solar panels placed on the roofs of buildings,

able to guarantee the lighting of common areas, and half of the hot water demand for domestic use. Hammarby Sjöstad has a short, closed-loop recycling system, in which the inhabitants contribute to "produce" up to 50 % of the energy required simply by producing waste, while the remaining 50 % comes from other clean sources: solar, water and wind farms.

Today the town plan of HS is the largest work carried out in Sweden over the last 30 years. The project cost amounts to about 22 billion euro, of which 4 have been spent on the construction of infrastructure.

In summer 2005 a service station was inaugurated to supply the first hydrogen car, already produced in this country and that are added to green public buses, with which the City of Stockholm is gradually replacing the old transportation means (160 ethanol buses).

Walking in the neighborhood is enjoyable: it seems that it is possible to go in any direction without encountering interferences, everything is pedestrian, from the banks of the canals, squares, bridges, residences with direct access to water. In fact, as well as in the part of Stockholm that was built in the postwar period, even here it is hard to distinguish public from private spaces, green is the structure of all the spaces, avenues, gardens, loggias, balconies, and there are no fences, everything is accessible as in a green and open city, thus increasing the quality of life [50].

To the north, there is the Djurgården, the former royal hunting reserve, which is now the most urbanized part of the Ekoparken, first national urban park in the world; it extends on 27 km^2 around and inside the city. It is a park that combines urban and natural environments, with a great variety of landscapes, hills with centuries-old oaken trees, lakes, sea bays, meadows, secluded rocky hilltops; also encompasses parts of town, museums, theaters, residences, sports facilities. The Ekoparken is an important piece of the project of "green wedges" or "green ways" that cross the city, a strip of forest that creeps between the districts and allows humans and animals to move for kilometers from the city center to the wild forests that are in the north.

The green infrastructure is not interrupted by streets. Furthermore thanks to a bio-sociotope approach, in developing the project, have been sought all synergies between the functions related to the entertainment of the citizens and wildlife needs, to allow people and animals to use the same space drawing mutual benefit. For example, it has been shown that the gardens and vegetable gardens are excellent points of support of the ecological network, places where animals find food and hiding places, as well as cycling networks, strictly separated from the road, can be ecological corridors for small mammals. Depending on these opportunities, the city government promotes management agreements to support the residents in the care of their property and green spaces taking into account the "ability to provide services" to the fauna.

The added value of this experience is the integrated urban planning that is a process that involves more than technical (by planners designers) also the public administration, the citizens, the development companies. Since the preliminary stages of the project, in fact, the various authorities and offices, which normally are interested in different phases of the project, have met and have drawn together the

plan in this new conceptual approach. “Hammarby Sjöstad Project” [51] is also an organization that acts in coordination with the Municipality of Stockholm and with the Department of Urban Planning: these entities together are responsible for the design and implementation of the District. The skills include finance, planning, land reclamation, construction works and construction of infrastructures. The Hammarby Sjöstad project will be concluded shortly, but it can be assumed that the objectives have been achieved and that they could be considered a best practice to demonstrate the inherent potential of this design and planning mode.

In 2030 Stockholm will be the global leader as regards the development and application of new technologies in the field of energy and environment: as of now it is starting the construction of new neighborhoods, which will have the model function on a global scale. As mentioned before, Hammarby Sjöstad has since long time attracted international attention and helped to position the Swedish capital on the map of the cities that are in the first places in the world for the sustainable urban development [52].

Another very big project still under construction is the Royal Seaport [53], which will enable the city to achieve another important goal. Located in the Norra Djurgårdsstaden neighborhood, in the northeastern part of the city, the Royal Seaport district will be the new major urban development area. Here it is planned to build by 2025 an innovative and sustainable district; issues related to environment and energy have gone through all the stages of urban planning of the area, which began in early 2000, which provides inter alia for the creation of 10000 new housing units, the first already built in 2011. The new development area focuses on sustainable transport solutions and will be realized through efficient building processes [53].

The area is located on the seashore and borders the first national urban park in the world, the Ekoparken, a large area outdoors, very popular because of its floral and faunal wealth, but also of its different cultural attractions. In this case, the city government has imposed environmental requirements even more ambitious than those of Hammarby Sjöstad: buildings should consume less than 55 kWh/year/sq m, the district Royal Seaport will be completely independent of fossil fuels by 2025 and completely autonomous from an energy point of view, also the parking spaces will be half of housing. The recovery must be harmonized with the Ekoparken and the park, conversely, will be the defining element of the project, with the nearby Olympic Stadium, the University campus and the Main Hospital at the Karolinska Institute.

The project generally aims to:

- Deepening the analysis of the Hammarby model, a supply of local energy production system model based on waste, sludge, heat recovery from waste water and district heating;
- Developing scenarios for the entire urban district in order to investigate and show the vision and environmental policy objectives for the urban district;
- Organizing “laboratories for the future”, focusing on issues concerning strategically smart living climate and innovations for sustainable urban development.

3.2.2.4 Current Projects and Recent Experimentations

Through effective governance and a long-term strategy, the city of Stockholm, in recent years, has positioned itself among the most modern cities in the development of Information and Communications Technology (ICT). Some new technologies will be developed and used to pursue sustainable development goals into a model of smart city and neighborhoods. To do this, Sweden has developed a number of projects to strengthen the link between universities and private companies. The technological center of Kista in suburban Stockholm, for example, was created following this logic to develop research and technological innovation of the Ericson group. Today the group has more than 600 companies with 30000 employees in the ICT sector. Ericson remains the leader of the projects implemented with the support of specialized universities and major research centers in Internet and broadband services. Encouraged by the public power certain Swedish technology centers have gained a real weight and international visibility, and now constitute a European model of successful clusters.

Example of how Sweden is at the forefront in this field is the partnership put in place recently with Morocco [54]. By an initiative of King Mohammed VI of Marocco, in fact Morocco will focus on smart cities to enhance its own territory and revive its economy. As a consequence in 2013 an alliance with Sweden started for a urban development plan of 9 million eurso. They are planning to build new towns that will host about 1 million people on a total area of 5000 ha. That's how Stockholm, elected Green Capital in 2010 [55], will be able to offer its know-how to other companies who want to become competitive through the development of smart technologies.

Among the future projects of the city of Stockholm, there is the development project in one of the suburbs of Stockholm (Jarva) [55, 56], which is about to become the most productive solar district of Sweden. In fact when the new solar power plant Familijebostader will be active, the city will double its solar production. On November 11th 2014, the first part of the structure was inaugurated. In total the six covered buildings will produce 350000 kWh of solar energy per year. The solar cells will contribute to a reduction of carbon dioxide emissions of 230 tons. This is equivalent to the use of a washing machine at 60 °C, 350000 times. In the second stage, three additional buildings in Rinke by will be covered with 1150 m^2 of solar panels. They will generate 150000 kWh per year. In total more than 10000 m^2 of solar panels will be installed on 40 rooftops in the Jarva area. The work is a joint effort between Familebostader, Svenska Bostäder and the housing stock of the city. The work is part of Hllbara Jarva project.

3.2.3 Freiburg

Freiburg[11] is a city in western Switzerland, capital of the canton of Fribourg (Switzerland hosts in total 26 cantons; they represent the states that make up the Swiss Confederation, i.e. the state of the Swiss Confederation). It is at the center of the historic region of Üechtland. In particular, Freiburg is located between Bern (capital of Switzerland) and Lausanne (capital of the Vaud canton); it has a river (La Sarine) which runs through the town. The canton of Fribourg is full of small and large lakes, like that of Neuchâtel and Murten. The region is very green and extends between the Swiss Plateau and the Fribourg pre-Alps.

The entire area of Freiburg also enjoys a mild and sunny climate, in fact it is the warmest region of Germany. It has more than 1800 h of sunshine a year and an annual radiation intensity of 1117 kW/m^2. The town itself has just over 220000 inhabitants and offers many cultural, historical and architectural heritage, including the emblem of Freiburg, its Cathedral with its high Gothic tower, the ancient craft building Kaufhaus, the ancient doors of the city or the green Schlossberg hill.

Even town planning is a tradition in Freiburg and this is especially accentuated by known Bächle, small grooves filled with water, more commonly called "streams" (about 30 cm wide and about 10–15 cm deep), present in the pedestrian streets of the city center; once they were built as part of the sewerage system and used to meet the fire emergencies.

From the nineties on, the city has made an environmental vocation choice and today, even for tourists, the value of this is remarkable. Thanks to a high level of environmental sensitivity Freiburg is a city with many green spaces [57], and also has become, definitely, a "sunny city". Here the opportunities offered by solar energy have been recognized earlier than elsewhere. The solar panels are everywhere, on the roofs of the Badenova stadium, on the city's Town Hall, but also in schools, in churches and in private homes, on the facades and on the towers. So much so that, for example, the local football stadium has become an attraction as the first stadium in the world to have its own solar system. This pioneering action has been reinforced by numerous awards that have led a large number of visitors to visit some of the projects that are unique in terms of energy (for example, the first solar building in the world self-sufficient from an energy point of view, the 'Heliotrope, the solar village designed by Rolf Disch, or the zero energy houses of the Vauban district).

The pride of the municipality is in fact the Vauban district [58], completed 3 years ago. All the houses inhabited by the more than five thousand residents produce more energy than they consume through efficient buildings, solar panels and solar thermal collectors. Another amazing aspect is the traffic management. In Vauban, the number of cars per inhabitant ratio is seventy per thousand, this is because mobility has been revolutionized through a careful analysis of the transport needs of the inhabitants and have been offered alternative solutions, such as car

[11]Inhabitants 229,144 (2011); Surface 153.06 km²; Density 1497.09 km².

sharing and cycling trails. The reality of Freiburg is so unique to have triggered also a specialized tourist market, with groups of professionals involved in urban planning, energy and architecture that arrive from all over the world for what has been dubbed precisely the "Freiburg Tour".

3.2.3.1 Smart Mobility and Smart Policy

From the analysis of the mobility it can be seen that Freiburg is a city committed to environmental issues since the seventies. As early as 1969, the city of Freiburg is committed to developing an urban transport policy that sought to ensure a good level of mobility that does not invade urban development, nature and the environment. The traffic of Freiburg and transport policy developed in the city has attracted international attention because it gives preference to transport systems compatible with the environment (pedestrian traffic, cycling, local public transport).

The city was recognized for his commitment to the "European Local Public Transport Award" [59]. Among the successes of the transport policy we should remember that between 1982 and 1999 thanks to the contribution of cycling, the volume of traffic in the city has decreased from 28 to 15 %. At the same time, public transport increased from 11 to 18 %, while the distances traveled by motor vehicles decreased from 38 to 30 %. Compared to other German cities today Freiburg has the lowest density of motor vehicles, with 423 cars per 1000 people. The measures taken are to draft a compact city that can be crossed rapidly and that includes strong neighborhood centers. Urban development should take place along the main transport arteries and priority is given to the development of centralized device growth. The restricted traffic area is zoned and the majority of households do not own a car. The private motor vehicles are parked in one of two of the neighborhood garage. Since 2006, the residential area has been linked to the city's tram system, enabling many people to do without the machine, using the local public transport or using the bicycle.

Waste management is a primary concern [60]. In fact, in the district, paper, plastic, organic material are fully recycled. The volume of waste per capita is well below the national average. The city itself is a good example, using about 80 % of recycled paper. The concept of recycling was introduced in 1991, and was supported by all sectors including the football club SC Freiburg, which has agreed to support the initiative. Waste reduction is rewarded through a system of incentives: the benefits are granted to households for the use of textile diapers, there are discounts for collective waste disposal and for the people who produce compost for plants through the disposal of their waste. Also since 2005 the non-recyclable waste in the region is incinerated at a facility in the Breisgau industrial park, located 20 km south of Freiburg. The plant's safety practices of waste disposal are very rigid and maintain high environmental standards. The energy generated by the fermentation of organic waste bio covers 1 % of the Freiburg energy demand.

Consumers awareness about recycling is constantly raised through campaigns and events. Since 1994, a disposal company Waste and sanitation (ASF) partly privatized in Freiburg organized in partnership with schools of Freiburg Eco-Station, courses and guided tours, a garbage Theatre for children in elementary schools, competitions and teaching units, such as "Ideas, not waste" or "Children and Agenda 21".

3.2.3.2 Sustainable Neighborhoods: Vauban, Siedlung Solar and Rieselfeld

The Vauban district is an interesting example of residential settlement. It was made with the participation of residents that have actively participated in the planning stage. The project is based on a great attention to the environmental, social and cultural fields.

The promoters of the project were the City of Freiburg, the NGO Forum Vauban, the owners' committee, the building coop Genoa, the independent committee SUSI, some private construction companies, the Eco-Institute for Applied ecology of Freiburg and some other companies.[12]

The district is about 15 km from the center of Freiburg and is located on the areas previously occupied by a French barracks abandoned in the early nineties. A big boost to the realization of the district came from the Forum Vauban, the NGO founded in 1994 and in 1995 by the choice of Freiburg as a formal representative of the community as well as in charge of participatory processes and the involvement of residents in the planning. The Forum contributes to the construction of social networks and good neighborly relations; in fact, it gives voice to the needs of residents, developing innovative concepts in the environmental and social care participatory aspects and those of communication, including the publication of a neighborhood newspaper, *Vauban Aktuell*.

The district consists of two thousand homes for a total of about 5000 residents, was built in accordance with criteria related to sustainability [61, 62] including: balance between residential areas and productive areas, and also between social groups; respect of the existing vegetation; priority to pedestrians, cyclists and public transport, with the aim of reducing the use of cars and promote the accessibility of public spaces, especially by children; delivery of services on-site [63]; participatory planning of green areas and adoption of architectural and technological choices aimed at reducing the demand for energy and solar energy development. In fact, the installation of thermal solar and photovoltaic panels makes Vauban one of the European neighborhoods with higher densities of solar technology [64].

[12]ITC (International Training Centre), the ICLEI (International Council for Local Initiatives Environmental), FEW (the multi-utility Freiburg for water and energy, today became Badenova), FAG (the agency car sharing Freiburg), Baugemeinschaft Modellprojekt Passivhaus Vauban/Wohnen & Arbeiten (pilot project for living together "Living and working").

The Siedlung solar, designed by Rolf Disch, a renowned architect in Freiburg, instead is a housing development built in 2001 adjacent to the Vauban district. The solar district meets the ecological and economic requirements; in fact it consists of houses, which can produce more energy than needed.

The civic engagement and collaboration among the inhabitants are important in this district. Close to a natural reserve area covering 205 ha that serves the inhabitants of Rieselfeld as a "green belt".

The neighborhood is located on an area of 70 ha that became available from brownfields. The planning principles that are the basis of the intervention relate to the construction of multiple housing units and over 5 floors high—so high population density—and then the application of the concept of adaptive urban planning, incorporating the concerns of families, children and disabled. Overcoming the classic "home-work division" has allowed the integration of industrial development zones in the district. All homes are built with low energy consumption. In many homes both solar photovoltaic and solar thermal units are installed. The energy produced in the district is of different origin: renewable energy and district heating together with a combined heat and power plant complete the framework on energy supply. In the urban space green spaces, playgrounds, open spaces, cycle paths and roads with restricted traffic that allow children to spend free time in the company have a basic importance.

3.3 Mediterranean Cities

The following section deals with some examples of smart city from the Mediterranean area. A special focus is given to the Italian cities. Those that since 2014 [65], and still today, fall within the "podium" of the Smart City Index ranking list in Italy are analyzed. The Smart City Index measures the smartness level of all 116 italian provincial capitals through several indicators for the various characteristics,[13] with the aim of providing a tool to measure, understand and compare different local situations, together with a dynamic and objective methodology.

The basic feature considered for ranking is the level of "intelligence" in each city for the various characteristics that make up the smart city. The connotation of the ranking, then, is highly technological because is focused on the digitalization of services and the use of Information Technology. Italian cities offer a very delicate context—historical centres and architectural heritage—where in most cases invasive interventions, infrastructural or not, are stopped for reasons of conservation. It thus seems very interesting to present some examples of excellence that, dealing with many local Italian contexts, implement soft, non-invasive, but effective actions that allow the achievement of high efficiency targets.

[13]Characteristics components of the smart city (Mapping smart cities in Eu, 2014, Brussels). Smart governance, smart economy, smart living, smart people, smart mobility, smart environment.

"Italy has a great heritage that the whole world envies us: the historical centres. And I think the real challenge for the future is precisely to understand how these new light technologies, through networks and digital sensors, can help us to get the best from these cities" (Carlo Ratti).[14]

3.3.1 Bologna

In many Italian Smart Cities rankings, [66] Bologna holds one of the first positions.

Bologna[15] is located in the Padana plain, Po Valley, on the Apennine hills between the terminal parts of the Reno valley and of the Savena valley. The absolute minimum temperature of the last 20 years recorded in the city was of −11.6 °C (February 9th, 1991); summers are hot but as not muggy (less humidity percentage) as they are in other cities far to the north on the Po Valley; summers can also be very long, dry (as in 2003 and 2012). In July and August temperatures above 37 °C are common. The success of Bologna in the Italian Smart City rankings is due to a strategic alliance between research, business and public administration, in order to develop useful solutions to address social and urban issues, by putting technology at the service of citizens. The goal of the City Council is to optimize resources and qualify existing city services, creating opportunities and enabling citizens to participate and to contribute to their development. Thanks to this alliance Bologna has gained a very good level of innovation. Citizens have access to a high level of broadband coverage, thus making faster and more efficient city services: for example, citizens have the opportunity to book medical care, to pay medical fees and collect reports using a web-based platform (Smart Healt). A high number of schools and classrooms have digital blackboards connected to the Internet (Smart Education), citizens can use electronic tickets for public transportation, get real-time information on traffic, parking and buses (Smart mobility); they can also have access to online services throught the Electronic Identity Card (CIE) and National Services Card (CNS), to require certificates and finally, citizens have the opportunity to enroll their children paying school fees on the web (Smart Governance).

For the energy sector, citizens can take advantage of the city district heating network. They have systems of well-equipped public lighting systems with LED lamps and flow regulators, thereby achieving a good level of energy efficiency. The city of Bologna also has a high installed capacity of photovoltaic panels on public and private buildings.

Mobility is powered by shared public means ranging from bycicles to cars.

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[14]Interview to Carlo Ratti (professor at MIT e Director of the MIT Senseable City Lab) "Nuove Tecnologie e Pianificazione Strategica: le Smart City del futuro" in http://recs.it/it/intervistaacarloratti.

[15]Population: 384.184 (2013); area: 140.73 kmq; population density: 2729.4 n/kmq.

3.3.1.1 Bologna Smart City

Bologna has managed to achieve such a level of innovation thanks to the implementation of specific and different actions, plans and programs.

To achieve the Kyoto Protocol[16] goals and meet the commitment to keep the global temperature rise below 2 °C [67] cities play a fundamental role as they can improve a lot energy efficiency.

Improving energy efficiency of a city means to take actions on existing buildings, mobility, urban density, the way energy is used and increase the amount of energy produced locally from renewable sources.

The EU in order to improve the energy efficiency of cities and energy production from renewable energy sources is operating with different programs. The well known "Climate-Energy Package 20-20-20" [68] and, more recently, the "2030 climate & energy framework" and the "2050 energy strategy" have increasingly ambitious targets for member states. These targets are then modulated for each country and in Italy are then turned into local targets at regional level.

In Bologna, the tools[17] for sustainable energy planning have been set up for the first time in 1982 with the BEST experience and have continued up with the "Urban CO_2 Reduction" Project in 1995 [69] and with the Municipal Energy Plan in 1999 and, more recently, with the approval of the new Municipal Energy Programme in 2007.

The 2007 Municipal Energy Programme is the outcome of a work based on territorial data collected through a GIS[18] system in order to define strategies for different areas of the city and evaluate the energy impact of new settlements and renewal projects.

The Municipal Energy Programme, the last energy planning tool for the city, selects homogeneous city's areas for energetic, urban and environmental characteristics and defines a set of specific performance standards in each BEU (Energy Urban Basins) to bring a reduction of greenhouse gases emissions in each new urban context identified in the new Urban Plan. This allowed an integration of energy plan strategies within the new city Urban Plan and Building Code, in terms of specific rules and requirements for urban projects.

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[16]The commitments undertaken by cities with this document are related to the reduction of emissions of carbon dioxide (CO_2), methane (CH_4), nitrogen monoxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6) by 2012.

[17]In 2008 the Municipality approved the new Municipal Structural Plan, a planning tool defined by regional laws (L.R. 20/2000). The Structural Plan is valid for the mid-long term (around 15 years) and lays down the general aims that are then interpreted by the Municipal Operative Plan approved in 2010, which however has a term of 5 years, and by Urban Building Code approved in 2009. The Municipal Structural Plan bases the feasibility of its forecasts on an environmental and territorial sustainability assessment (VALSAT) which considers the environmental impact of proposed actions, associating them with rules and limits pointed out in environmental sector plans.

[18]Geographic Information System.

Together with to the first setting of tools for energy planning, also district heating networks development started as well as the installation of renewable energy sources within the urban context. The Municipal Energy Program of Bologna identifies 16 areas of action on which the actions have been set. These are referred to: energy saving in buildings; development of renewable energy, solar thermal and photovoltaics; savings in the electricity sector; savings in the transport sector.

Finally, the city of Bologna has joined, in 2008 (Resolution Odg 230/2008 PGN 277949/2008 of the City Council), the Covenant of Mayors [70] in order to fulfill the obligations outlined in the subscription of Italy to the Climate Energy Package 20-20-20. The first step to implement, for the Covenant of Mayors signature, is to make up the Action Plan for Sustainable Energy (PAES), which lists actions to improve energy efficiency in the city. The guidelines developed by the Joint Research Centre, JRC, of the European Commission on how to develop an Action Plan for Sustainable Energy claim: "Adaptation of city structures, including the allocation of sufficient human resources is a formal commitment by the signatories of the Covenant of Mayors. Therefore, all Covenant signatories should adjust and optimize all their internal administrative structures. They should designate specific departments with appropriate skills and allocate human and financial resources in order to fulfil the commitments set out in the Covenant".

To draft the PAES of Bologna, the Municipal Energy Program of 2007 [71] has been taken as a reference. The PAES [72] describes the guidelines for the efficient use of energy, through a detailed definition of the individual actions to be followed and that are necessary to achieve the objectives. As regards the inventory, the Municipal Energy Program of 2007 provides data up to 2004[19] and does not distinguish between installations subject to Emissions Trading Scheme[20] and installations that are not subject to such scheme (introduced in 2005). Although it also contains some parts related to energy consumption, consumptions for public lighting and municipal transportation are not explicitly reported. Therefore, to draft an inventory updating data since 2005 and consequently the PAES, it was necessary to review and update all the data collected in the Municipal Energy Program.

[19]Reference Year for Italy for the inventory of emissions.

[20]European Directive CE/2003/87 October 13th 2013. The EU ETS works based on the 'cap and trade' principle. A cap is set on the total amount of certain GHG that can be emitted by installations covered by the system. The cap is reduced over time so that overall emissions get reduced along time. Within the cap, companies receive or buy emission allowances which they can trade with one another as needed. They can also buy limited amounts of international credits from emission-saving projects around the world. The limit on the total number of allowances available ensures that they have a value. After each year a company must surrender enough allowances to cover all its emissions, otherwise heavy fines are imposed. If a company reduces its emissions, it can keep the spare allowances to cover its future needs or else sell them to another company that is short of allowances. Trading brings flexibility that ensures emissions are cut where it costs least to do so. A robust carbon price also promotes investment in clean, low-carbon technologies. According to the Convenant of Mayors rules, industries under the ETS should not be considered in the emissions inventory.

Moreover, joining the Covenant of Mayors means for signatories the obligation to draw up an inventory of the total amount of CO_2 emissions (Baseline Emission Inventory, BEI).

Finally, on July 30th, 2012, the municipality of Bologna and the University and Aster[21] have signed a memorandum of understanding for the establishment of the platform project "Bologna smart city" in order to rethink the city and enhance the knowledge and technological innovation, through the extensive use of ICT, and to address the economy and the lifestyles of their inhabitants. While focusing on research then, the city of Bologna is investing in energy, services, digital technology and cultural and environmental heritage.

The Bologna Smart City Platform has characterized 7 different thematic areas on which its action could be developed:

1. Cultural Heritage (Valorization and upgrading of historical and cultural heritage and tourism)
2. Iperbole 2020[22] (Re-designing of the Civic Network Iperbole);
3. Intelligent networks (smart grid), Ultra-widebrand *Fiber to the Home* (FFTH) e *Smart Lightning*
4. Sustainable mobility (development of a smart eletric mobility network)
5. Safe districts: (retrofitting of public and private heritage, monitoring building safety, waste management, home automation and new environments for knowledge workers and researchers)
6. Health and wellness (*e-care*, *e-health*, processes optimization and *business intelligence*);
7. Technical education (development of projects in education, promotion of new technical and scientific knowledge).

The "Bologna Smart City" project has also helped the Digital Agenda of the town, which aims to make the city of Bologna smarter, laying the foundation for sustainable development based on ICT.

The city of Bologna since 2012 has successfully inaugurated the "Smart City Exhibition", event and physical place of discussion for public administrations, businesses and research organizations focused on the smart city topics. A place where projects, difficulties encountered and the new challenges for Italian cities can be discussed.

The conference that took place in the last edition (October 16th 2015, Smart City Exhibition, 2015) entitled: "Meet Smart cities: where smart cities meet innovation" [73] was an opportunity for social innovators to meet with urban policies so as to boost the capacity of fundraising supporting projects of urban transformation.

[21]Consortium between the Emilia-Romagna Region, Universities, CNR and ENEA, whose aim is to promote innovation in the production system, the development of facilities and services for the industrial and strategic research the collaboration between research and business and the optimization of human resources.

[22]"Iperbole 2020" is a project of the City of Bologna to experiment citizens' involvement through the use of social media.

The cited initiative "Meet Smart Cities", a competition promoted by the National Observatory of Smart City, is in line with the convention that binds the Association of Municipalities in Italy, ANCI, and the National Youth Agency in the promotion of the participation of young people in social innovation for intelligent urban community construction, with the support and collaboration of the Smart City Exhibition initiative.

During the closure meeting of the initiative, on September 2nd 2015, Mayors, Councillors and managers of Observatories interested in the development of city services and innovative policies took part to the meeting. Participants have had the opportunity to listen and deepen the proposed solutions as well as to analyze the opportunity to adopt them in their territories. Also companies and potential private lenders have took part in the meeting.

3.3.1.2 Smart Energy

One of the most important aspects to achieve sustainability in the building sector is, without doubt, the use of renewable sources to meet both the electrical and thermal requirements. Many municipalities, in recent years, have adapted their Municipal Building Regulations, introducing the installation of photovoltaic panels and solar thermal or the installation of other types of renewable energy sources (micro-wind, biomass, etc.) as mandatory requirements [74]. The production of electricity from renewable energy sources in the territory of the municipality of Bologna until 2001 relied on a hydroelectric plant and on two biogas plants (wastewater treatment and landfill waste). Since 2002, there has been an increase of installations of photovoltaic energy systems, which have had a significant acceleration with very convenient feed-in tariffs. All installed equipments do not exceed 20 MW and therefore, as detailed in the Guidelines of the JRC; they must be considered in the emissions inventory.

From some data analysis, it is possible to note how the energy production from hydroelectric energy has been decreasing along the years, due to some problems of water management of the supply channel.

Since 2007, thanks to the functionality of the wastewater treatment plant IDAR, the production from biogas is significantly increased. Similarly, since 2007, a considerable and progressive growth of photovoltaics was observed and in 2009 such source achieved levels that are comparable with the production of biogas. The Municipality of Bologna shows in 2005 a production of electricity of 12909 MWh from renewable energy sources and cogeneration.

This production has been increasing over the years thanks to the national incentive mechanisms and through the legal obligations imposed for the new buildings.

With respect to the heating requirements for buildings with the European Directive 2002/91/EC on Energy Performance of Building and its implementation in Italy with Legislative Decree 192/05 and Decree 311/06 has made explicit the requirement for installation of renewable energy plants to fulfil the heating

requirements of the building, relatively to the share of the production of domestic hot water. The Emilia Romagna region has implemented the obligations of the two Decrees 192/05 and 311/06 in the Dlg 156/08. On the other hand, the region has granted that the requirement can be fulfilled if an equivalent amount of power is obtained through high performance cogeneration and fossil fuel or by connecting to the existing district heating network. Article 51 of the Municipal Building Regulation of Bologna states that: "…the district heating network (named TLR) is composed of plants producing heat and possibly cogenerate electricity…".

In order to reduce the consumption of energy from non-renewable sources, the energy production, recovery, transport and distribution infrastructures employing renewable sources and assimilated must be considered. In the case of a new cogeneration system and its network of heat distribution (and possibly cool), the values of energy performance defined by Decree No. 20/2007 and the resolutions of the Authority (IRE min, LT min) must be respected.

For electric power plants with rated power below 1 MW, the overall performance ratio (the ratio of the sum of useful electricity and useful thermal energy over the energy content of the fuel used) must be at least 70 %. For installations exceeding 1 MW, the same performance ratio must be at least 75 %. If the plant of TLR is not connected to a cogeneration plant, the efficiency (ratio of heat provided to the users and energy used) must comply with the minimum of 85 %. The plant design must be accompanied by a study that highlights the energy-environmental advantages for comparison with other high efficiency solutions."

The energy efficiency issue and related energy savings is addressed by the European Directive 2012/27/EU on efficiency in final-use of energy and energy services and by the Italian transposition law (Legislative Decree no. 115/08) which puts a number of provisions also for public administrations (art. 12, 13, 14, 15).

The Emilia Romagna Region, with the Regional Law n. 19, 29/09/2003, has laid down rules for the reduction of lightning pollution and energy saving for public lighting.

In Italy, energy consumption directly chargeable to public lighting amounted to 2 % or approximately 6 TWh/year.

This figure decreases for the city of Bologna, where it accounts for 0.4 %. With regard to the containment of electrical energy consumption, the law requires that the new lighting systems must have a degree of efficiency at least equal to the lighting systems based on sodium vapor lamps. Lighting systems must be equipped with devices that regulate the emission of light in certain hours defined by the municipalities of at least 30 % compared to the values at full capacity. Obviously, such instructions apply also to the retrofitting of existing plants.

To support and encourage energy saving, the necessary interventions in public lighting systems are recognized within the Energy Efficiency White Certificates scheme [75]. Besides, the Municipality of Bologna in order to be able to achieve energy savings has recently signed an agreement (lasting 9 years) with Enel Sole.[23]

[23]ENEL Sole is an Energy Service Company.

The administration ensures that the new contract will guarantee more efficiency and quality, with advantages in terms of energy conservation and retrofitting of plants.

Furthermore, the type of new system to be installed is used as a "base" for the exploitation of other technologies, such as wi-fi or cameras for video surveillance (intelligent lighting poles).

Thanks to the agreement with Enel Sole will be invested approximately 6 million of euros for the replacement of 24000 bulbs (with increased efficiency of at least 30 %) and 1000 km of cables to create a network of remote control that will involve about 30000 light points (66 % of those that are installed) ensuring Municipality savings between 450000 and 500000 euros per year.

The new system, finally, will also increase the use of LED lighting since the latter can reach a luminous efficiency of 120 lm/W, which makes them fully comparable to high pressure sodium vapor lamps.

LEDs additional benefits are:

- High lifetime (up to 100000 h, against 20000 of sodium lamps), greatly reducing maintenance costs;
- Immediate switching and possibility of light regulation with different methodologies;
- Possibility to define light color from warm or cold shadings (that of sodium lamps is typically yellow). The LED lamps are also the solution currently adopted for the traffic light redevelopment.

3.3.1.3 Smart Mobility

The Urban Traffic General Plan (PGTU), approved in 2007, is the municipal planning tool aimed at improving traffic conditions and road safety, reducing noise and air pollution. Another main aim is to produce energy savings, in accordance with the existing planning instruments and transport plans and with respect for environmental values .

The Plan reorganizes the urban mobility in the short and medium term. The actions of the PGTU are aimed at an overall improvement of the citizens quality of life through measures for increasing public transport systems and reducing private mobility, the increasing number of bicycle paths and for improving deprived sub-urban areas. Reducing air and noise pollution are also main objectives of the Plan.

To ensure a smoother traffic flow, solutions have been designed to follow the geometric shape of the road section with appropriate adjustments and treatments of the road surface; in this way, it was possible to improve the safety of cyclists and pedestrians.

Also with the objective of encourage the daily use of bicycle, the number of kilometers of cycle paths has been increased from 60 (2004) to 94 (2010), in addition to this, also 30 km of nature trails and 4 km of cycle-paths on open bus lanes have been created, so that the total network is now 128 km long. Pedestrian

areas have been increased as well from 65,000 m^2 in 2003 to 103,200 m^2 in 2010 with an increase of 60 %. With regard to local public transport, the ATC (Municipal Transport Company) has continued in recent years its entire fleet renewal. With regard to urban bus service, those powered by natural gas have almost tripled, rising from 54 in 2004 (10 % of the total) to 149 in 2010 (31 % of the total); hybrid buses are now 41, while the trolley buses and electric buses are 68 in 2010: the three types of buses represent 23 % of the total fleet.

The Bologna Municipality is carrying out in recent years (2015–2016) several projects for shared and sustainable mobility (bike/car sharing) including Biciplan project [76] and others.

The European Investment Bank (EIB) [77] has recently (2016) approved fundings for 50 million Euros for the project "Urban Environment" of the City of Bologna and for the multi-year programme of public works and investments from 2016 to 2018. The funds will go towards the construction of bicycle paths and pedestrian areas, the promotion of smart mobility solutions (and for safe road solutions), the construction of public infrastructure and public spaces for social inclusion. A big project, aimed at improving the quality of life, urban regeneration and development of smart city & smart community projects.

3.3.2 Torino

The City of Turin,[24] located in the western part of the Po Plain, covers an area of about 130 kmq, mostly flat. Surrounded by the Alps and the hills, crossed by four rivers (Po, Dora Riparia, Stura and Sangone), it has an environmental heritage that few cities in the world can boast and one of the highest urban standards of green area per capita: 18 million m^2 of green areas, continuously expanding.

The resident population of Turin city center, in 1991, amounted to 979839 inhabitants, and it dropped over the following years, reaching the historical minimum in 2002 (896818 residents), for the benefit of the metropolitan area municipalities, gradually grown in population. In subsequent years, there has been a slight increase of population, mainly due to the increase in the number of foreigners.

Always identified as the automotive industry's capital, Turin was the main actor, in the last three decades, of an important process of transformation, from an urban, cultural and economic point of view.

According to Köppen Climate Classification,[25] Torino belongs to the C band: temperate climate of the middle latitudes with warm summer (average absolute

[24]Population 905,444 (2012), Area: 130.34 kmq, Population density 6947.63 inhab/kmq.

[25]Köppen climate classification is one of the most widely used climate classification systems. It was first published by Russian German climatologist Wladimir Köppen in 1884, with several later modifications by Köppen, notably in 1918 and 1936. Later, Germanclimatologist Rudolf Geiger collaborated with Köppen on changes to the classification system, which is thus sometimes called —Geiger climate classification system.

temperature of the warmest month of not less than 22 °C), cold winters and no dry season. More precisely, Turin has a temperate sub-continental climate, with cold winters and relatively dry and hot summers. The productive decentralization in other parts of the country, started in the mid-seventies, has created massive urban empty spaces, characterized by a progressive decay that has affected, in particular, the areas located along the railway road that crosses the city from the north to the south in an almost barycentric position. In this area, since the beginning of the twentieth century, had been located the major industrial establishments, progressively embedded by the urban-residential expansion. The urban renewal, begun in the Nineties, has deeply affected the infrastructural system (rail transport system, main roads etc.…), the conversion of large abandoned industrial areas, suburbs and working class neighbourhoods with a significant involvement of inhabitants. The Olympic Winter Games which were held in Turin in 2006 [78] have left a legacy that is not just about material aspects, such as large sports facilities or the redevelopment of the rich cultural and historical heritage that Turin has, but also the international visibility of the city with a tourist vocation and able to host major international events.

Turin has never presented historically a fringed suburb, linked with the surrounding rural settlements system: each period of expansion has paid the formation of more or less defined edges, but always marked by their autonomous "centripetal" configuration, to the city, characterized by:

- High density of both occupied land and built volumes;
- Urban plant of compact zones: 3/5 blocks developed along leading road;
- Formation of "insulae" [79] [specialized for the production and for "great services" of the industrial city, intensively built and forming a barrier as compared to the rest of the city;
- Strong identity compared to external built elements, as out-door "villages", suburban historical centres, that once incorporated in urban development become decentralized polarizations, with own features (low density, system model along the road, not completed blocks, etc.…). Turin has experienced an overwhelming and uncontrollable growth dependent on structural socio-economic phenomena of the entire nation. The development is grafted onto an older and powerful urban structure, which succumbs only in the fifties, when the city, carrying out an unplanned growth, jumped from 700000 to over 1100000 (1980) inhabitants, and connected to the urbanization of the belt centers, setting up a complex metropolitan area.

The relationship between pre-twentieth-century center and expansions is marked today by large nineteenth-century strategic choices. In the areas of more recent urbanization some important connection to the urban system are now missing and the urban grid suddenly switches from axial knitted areas to autonomous plant zones with block buildings. The existing urban structure has a parallel axis system around an ancient core surrounded by just two or three main avenues. The parallel nineteenth-century road axes—developed in the 900—are made up of avenues,

while the large metropolitan road system, now passes throught radial avenues and rings consisting in ancient belts and their expansions.

Not least in the urban development plan is the relationship between the structural road system and the "rigid" elements of the wider territorial system: the river and the railroad.

The removal—or at least—the different role of the territorial infrastructure, through the implementation of major projects (such as the provision of rail axis modification in Turin), involves major upheavals and the formation of new segments of the more structural part of urban system. The new Master Plan [80] assigns the main role of urban renewal to the two "backbones", conceived as urban renewal axes, directly connected to the centre and periphery, based on the urban transformation potential, permitted by the railway system changes. Around the urban areas, built with similar intensity and attention to the central areas, the economic viability of the irrigated plain at the confluence of the two rivers (Dora and Stura) with the Po has generated a widespread settlement pattern, of rich and frequent farms, many of which are magnificent villas and still have densely innervated the territory with water and land system infrastructures. Residential expansions are preceded, in the history of the twentieth century in Turin, from localization of large industrial complexes, large services, however of external functions, which generated centrifugal traffic flows. Fiat (or the manufactures related to river water cycle) generated a multipolar system, essential structure of any metropolitan area, but also the primary factor for the making-up of interstitial urban voids, of intermediate unfinished areas, of "inner edge areas".

3.3.2.1 Torino Smart City

Recently Turin applied to become smart city [81] for the development of low carbon technologies.[26] It is the first Italian city that can boast concrete steps towards the transformation in a sustainable city, capable of responding—more and more—to citizens needs by reducing its environmental footprint. By joining the Covenant of Mayors, initiative which commits cities to reduce their CO_2 emissions by more than 20 % in 2020 with interventions and actions within the powers of local authorities, Turin has undertaken to draw up and implement its own plan of the Sustainable Energy Action (TAPE).

Specifically, CO_2 emissions fell in Turin from 6270591 tons in 1991 to 5100346 tons in 2005, a decrease of 18.7 % over the period. Per capita emissions in 2005 stood at the level of 5.6 tons/inhabitant.

The city of Turin is now working towards two main directions: energy recovery and sustainable mobility. The actions foreseen by the Action Plan expect to rise, by

[26]The Initiative "Torino Smart City" represents the new and ongoing innovation policy framework for the city of Torino. Its aim is to strategically design a new sustainable urban development policy framework in order to respond to upcoming societal challenges, thereby improving territorial competitiveness and becoming a better place to live, work and move.

2020, at an annual savings of about 350 million, with a direct economic benefit for people.

3.3.2.2 Turin Action Plan for Energy

The plan foresees a reduction in CO_2 emissions of almost 1.5 million tons per year, with a total result above expectations imposed by the European Commission for 2020.

The actions which will contribute to obtaining these results will mostly be undertaken in improving the energy performance of existing buildings (retrofitting), in the use of renewable sources, in the development of public transport to reduce the use of cars and the extension of district heating, which will serve 45 % of the residential volume. The economic results of the Plan will allow an estimated savings of nearly 800 million per year for the entire urban system. This is due to the implementation of very effective measures, realized in a short time.

The Action Plan for Sustainable Energy of Turin (TAPE)[27] processed according to information provided by the European Commission, includes:

1. the basic inventory of CO_2 emissions related to 1991 (chosen from Turin as reference year to quantify the reductions of emissions in 2020);
2. the Inventory of CO_2 emissions related to 2005;
3. the Action Plan is the set of actions identified and activated in the period 2005–2020 that promote energy savings, increase energy efficiency and the use renewable energy sources (51 actions in the fields of construction and service sector, industry, transport, local production of electricity, district heating, spatial planning, Ecological Public Procurement, stakeholders involvement);
4. the Executive summary where the CO_2 emissions data excluded the industrial sector are reported.

The most significant actions undertaken by the City until 2020 relate to three main areas.

1. Mobility

Mobility will be more sustainable thanks to the completion of the metro line and the construction of new sections, modernization of the public transport fleet, increased bicycle mobility and greater diffusion of low emissions vehicles. The measures for mobility will iply a reduction of CO_2 emissions by 2020 to 261679 tons/year.

[27]The milestones to remember are: January 29th, 2008 in the second edition of the European Sustainable Energy Week, Turin has expressed the willingness to join the Covenant of Mayors initiative. On May 20th 2008, there was the pre-accession to the Covenant of Mayors with the City Council Resolution. On January 19th, 2009 with the approval of a formal accession City Council Resolution of the City to the Covenant of Mayors. On 10th February 2009 in Brussels during the European Sustainable Energy Week, the official subscription to the Covenant of Mayors. September 10th, 2010 approval by the City Council of TAPE (Turin Energy Action Plan).

2. Buildings retrofitting

As for the buildings, they must be exploited through national, regional and local incentives to redevelop the property portfolio of the City and Region. For this sector, the CO_2 emissions will be reduced by 2020 to 259476 tons/year.

3. District heating network

The extension of the district heating network will serve 67 millions of m^3 by 2020. The extension of the district heating network will be the following:

- 2005: 29 million m^3 served;
- 2010: 40 million m^3 served;
- 2020: 67 million m^3 served;
- CO_2 emissions reduction to 2020: 567679 tons/year;
- Reduction 1991/2020: 41.90 % = 2627404 tons/year.

3.3.2.3 Smart Mobility

The urban traffic has become a strategic variable for the urban systems sustainability challenge, especially in Turin, where the motorisation rate is one of the highest in Italy. The solution to such a complex issue requires a strong commitment in terms of innovation, beginning with the urban policy methods and contents with the aims of reducing greenhouse gas emissions and decreasing traffic accidents. These are indeed the priorities of the Urban Plan of Sustainable Mobility (PUMS) [82] approved by the City Council of Turin. The latter is a strategic document that analyzes the Turin reality with regard to mobility and every project for the next 10–15 years.

The new plan defines guidelines, goals and concrete actions:

1. Access to the city area

The aim is to control the access to the territory, through the analysis of the demand expressed by citizens, from a systematic one to an erratic one to encourage the use of public transport, reduce congestion, protect the environment and improve the livability of places.

2. Accessibility for people

The PUMS supports the right of anyone to move in urban areas (walking, cycling, using public and private motorized vehicles), paying particular attention to the weakest people: children, elderly, disabled. It must be guaranteed easy accessibility to mass transit, facilitating their use both at bus stops as well as on board. It must be ensured the continuity and quality of pedestrian routes, eliminating physical barriers and environmental obstacles, making safer the intersections between pedestrian and vehicular routes.

3. Metropolitan/Tramline System

Policies that reduce the polluting sustainable mobility must be developed and encouraged. In this context the following types of mobility are supported:

- the "zero impact" slow mobility (pedestrian traffic and cycling);
- public and private transport with low impact;
- collective use of cars (sharing/pooling mobility systems), for which the measures imply the reduction of the share of private road transport for urban mobility.

The goal of the Urban Sustainable Mobility Plan of Turin is to make the public transport system, more competitive, to discourage individual journeys and reduce congestion thus improving access to urban functions. The PUMS promotes an integrated urban transport system, fostering intermodality between private and public transport modes. Safety and efficiency to the urban road network is also a main concern. The improvement of road safety is pursued in accordance with the objectives that are defined from the EU and the Piemonte Region while respecting the reduction of road accidents. The Plan indeed sets up projects and pilot actions in critical areas that will be evidenced by the data on road accidents and timely reporting of local stakeholders.

The use of info-mobility to manage urban traffic (public and private) is a versatile tool for the real-time reporting of all anomalies of the circulation (construction sites, events, limitations) and to provide decision support for the choice of paths and the most convenient transport mode (sms on mobile phones, on-board equipment, Internet). With this in mind, the extension of remote traffic management systems is growing more and more.

Finally the implementation of the plan through suitable governance means. The actions will be based on three key concepts:

1. Participation. Through periodic comparisons on the various topics included in the Plan.
2. Communication. Informative campaigns on the choices of the Plan and the Internet portal will be the implementation instruments.
3. Monitoring. Periodic surveys on mobility and quality of public transport

Another pillar of the plan is cycle mobility. Since February 2004, the City has approved the "Plan of Cycle Routes", which detailed the Urban Traffic Plan. The planned urban itineraries are planned also in relation to cycling suburban existing and/or planned network. The Plan provides for a development of the cycling network in the city area, which allows to go through the city along the main roads and that is functional to recent years urban development that has strongly influenced the change of Turin's urban fabric.

3.3.2.4 Smart Economy

The Turin Smart City Platform[28] will expand responsibilities, fostering the penetration of innovation in the urban landscape of Turin. Cross-fertilization of experiences between research centers, universities, industries, professionals, citizens, policy makers, will be an asset for new urban economy. The first step toward keeping the recognition of smart city is the involvement of entrepreneurs in the creation of "smart" city solutions. The areas will range from building to mobility sector, from infrastructure to electronics. For a transition to a low-carbon economy, a synergy between public and private sectors will be required, involving many enterprises and institutions of the territory. These actors, each with their own skills and resources, will play an essential role in reaching the goals set by the City. Turin will become a sort of experimental laboratory in the field of clean and efficient technologies. The "social aspect" is not only an aspect of Turin Smart City, but is also the aim and the work methodology. Turin Smart City will be characterized by its "bottom up" approach.

Strengths of Torino's Smart City policy:

- The project has a holistic and integrated long term approach;
- Strong accent on the benefits for the city-users;
- Social innovation as a key interventions axis;
- Sectoral prioritises are complemented by horizontal priorities such as administrative innovation and stakeholders and citizens' engagement;
- New territorial governance patterns—both in relation with the wider metropolitan area and with the industry—thanks to the creation of the so-called Torino Smart city Foundation.

3.3.2.5 Smart People

The skills developed in Turin will be called to a great effort to set up and test new large-scale solutions, systems, technologies for improvement of quality of life in the city. It is an effort that, in a decade, is helping to form a new leader class which is much more innovative, courageous and talented than that of today. Despite the innovative and forward-looking activities, the city implements specific initiatives such as the ecological Sundays [83]. Since 2000, the City of Turin, along with numerous other Italian cities, has organized sustainable initiatives by closing to traffic the central area of the city. The aim is to sensitize citizens on the environmental sustainability issues, pollution and sustainable mobility. The ecological Sundays have had, over the years, a great success and appreciation from citizens. It is in fact an initiative appreciated and now entered into the common culture of

[28]Torino Smart City Platform, led by the Torino Smart City Foundation, represents the project framework for the new urban innovation policy. Available at http://www.torinosmartcity.it/.

citizens as an opportunity to live and visit the city in a different way, with a strong symbolic value and an environmentally acceptable quality of life. The Turin appointment with the voluntary environmental part of the "Clean Up the World" initiative, a global event that sees Legambiente Italia as the Italian leader of the event and records the involvement of committees and associations [84]. Turin since 2013 participates in this initiative with several environmental events.

Green Weeks [85] is a project implemented by the Environmental Department of the City of Turin and the Turin Smart City Foundation in collaboration and thanks to the efforts of various associations. From May 20th to June 5th, 2016 the Green Weeks has been held, event promoted by the City of Turin and Torino Smart City Foundation to celebrate the World Environment Day and to bring citizens closer to the major themes of sustainability and Smart Cities. Green Weeks has offered an intense program of events and activities, in particular related to urban green issues, agriculture and organic food, cultural and artistic commitment towards the environment.

3.3.2.6 Smart Governance

To create a smart city, the current situation of the city, its metrics, numbers, consumptions, expenditures, using indicators produced such as tools of knowledge must be known. Besides, predictive simulation on future scenarios and assessing effectiveness of interventions put in place must also be known. The City of Turin, with the fundamental contribution of CSI[29] Piemonte, since 2013 has created an intelligent city dashboard. A system that collects and systematizes all structural and contextual, objective and perceptive data, returning a support analysis model and its decision-making processes to administrators. In the decision-making process also the citizens (human smart city or smart people) must take part, thanks to a web portal that provides information (but also training) on smart city projects. This is a major innovation in terms of communication: the public authorities, through the portal, educate citizens and ask them contribution and suggestions for all smart city projects.

A system that is also a shared design platform, in which citizens find the tools to understand the projects and then to give an active contribution. All the technologies and models developed by the city of Turin are designed to be repeatable and reusable in other contexts. The implementation of sustainable policies in administration also takes place through the e-government: the application of new communication technologies, including the Internet, managing the relationship between citizens and public administration in order to streamline bureaucratic procedures providing services and information online. The action plan for e-government aims

[29]To implement innovative services for the administrations, thereby helping them to be more efficient, modern and to reduce public spending costs. This is the mission of CSI-Piemonte (http://www.csipiemonte.it/web/en/) the Information System Consortium to which Piedmont's Public Administration entrusts the management and implementation of its ICT services.

to stimulate the use of modern information technology in the modernization of the administration of the country, through three types of activities:

1. Actions aimed at the digitalization of the delivery of services to citizens and enterprises, involving integration between the services of different administrations. The goal is to provide integrated services and not fragmented to citizens and businesses according to the competence of individual institutions of government;
2. Actions to allow end-users access to the services of the public administration and its information;
3. Digitalisation actions improving the operational efficiency of Public Authorities.

1. *Smart energy*

The field of application related to energy is a quite complex issue. To tackle the subject, it is requires the preparation of the Energy Report related to the energy balance of the Province of Turin. The provincial energy system is studied by analyzing the areas of use as listed next: Residential use (domestic and tertiary sectors); Transportation; Productive activities (industry and agriculture); Electricity production; District Heating. Linking the energy data with others from socio-economic and climatic source, some considerations that help to better analize the actual trends must be considered. In addition to energy data, it is possible to control the CO_2 emissions parameter compared to the Kyoto targets. The application of the analysis derived from the previous plan are being achieved in the Sustainable Energy Action Plan (TAPE). The interventions aim to the CO_2 emissions reduction through targeted interventions for each sector. In the Municipal Sector the following measures are accounted for in the TAPE (Table 3.2).

3.3.2.7 Sustainable District: The Buildings in Arquata Street

Polycity project respectively supports different aspects of urban development in three European cities: new buildings in locations which are still underdeveloped in the peripheral area of Barcelona, a mixture of re-development and new building in Scharnhauser Park, a former military area close to Stuttgart and finally the renewal of an old city district in Turin. The area of via Arquata in Turin is a good example of sustainable district[30] can be found: a housing complex of the beginning of the 20th Century [87], recently recovered (2007–2008), following the principles of sustainable building. The district—not far from the center of Turin—whose original planimetric configuration is with courtyard building showing good architectural quality (i.e. decorated facades) and construction, but over the years the deterioration and lack of maintenance had compromised the livability of the neighbourhood.

[30]The Torino Arquata district interventions have been supported by the Concerto initiative co-funded by the EC within the FP6. The POLYCITY project has developed different aspects of sustainable urban development in three European cities (Barcelona, Stuttgart and Turin).

Table 3.2 Measures of the TAPE targeted by final use

Sectors	
Services Industry	Reduction of energy consumption for heating of buildings owned by the Province of Turin
	Energy savings in hospitals in the Piemont Region
	"Dinamo-sunbathing" project for the photovoltaic improvement
	Increase volume served by district heating
Residential	Retrofitting of existing buildings
	Replacement of heat generators with high efficiency generators
	Incentives for the construction of demonstration actions in the energy field
	Tax Deduction for redevelopment of existing buildings
	Voluntary improvement of the energy performance of buildings already initiated by the energy certification[a] Incentives for the integration of solar PV in residential buildings
	Solar thermal diffusion
	Upgrading of via Arquata district
	Increase in volume served by district heating
	Incentives for energy efficiency of existing residential buildings
Public lighting	Replacement of mercury vapour lamps with low-consumption lamps
	Using led lamps for all traffic lights
	Widespread use led for light lamps [86]
Industry	Incentives for increasing energy efficiency in manufacturing facilities
	Incentives for starting production lines of systems for renewable energy sources exploitation
Local electricity generation	Incentives for the production of electricity from solar photovoltaic with feed-in tariffs

[a]The Piemonte Region with the approval of the Law 28 May 2007, n. 13 has identified guidelines, prescriptions and tools aimed at improving the energy performance of existing buildings and new construction and has also introduced the obligation of energy certification of buildings (http://www.regione.piemonte.it/energia/certificazione.htm)

Recently, different refurbishments have been implemented to reduce the energy consumption of the district while keeping equal or increased quality of life for the inhabitants. The intervention [88] has involved over 2500 inhabitants, 30 buildings, 622 apartments and a total surface of 110000 kmq. The main interventions are focused on energy savings for both the production of heat, and electricity. The district heating network throughout the complex has been completed, and a 100 kW photovoltaic system on the roofs of 16 buildings is being built; at the same time, about 500 lights are being replaced with energy-saving ones, while for a more efficient thermal insulation windows and doors have been replaced.

The estimate is about an energy consumptions reduction between 30 and 40 %: each year about 2000 tons of CO_2 equivalent will be saved equal to 52 % less than the emissions of the buildings before redevelopment. Through sustainable building principles the energy balance of the buildings has radically changed. These, from passive consumers, have been transformed into production systems, use and

management of heat, electricity, water and indoor climate. The use of natural materials, the use of renewable energy sources combined with intelligent electronic control systems to equipment and systems ensures high energy efficiency of buildings.

It is a project designed to create a place capable of fostering relationships, improving the quality of life and the environment, with positive effects on the psychological people well-being. Interventions involving the use of advanced solutions in which technology is used to create a new relationship between man and nature. For the project construction techniques, materials, intelligent and efficient systems for heating, cooling and internal control environment are being used.

The main performance areas covered by the Regulations, according to a statistical basis are:

- *Thermal insulation*: refers to all systems and constituent step up efforts to reduce the heat flux exchanged between different temperature environments. The thermal insulation in the building industry is aimed, mainly, to contain the heat inside the buildings. The heat insulation measures in buildings are regulated by regulations of the European Community to which designers and operators must comply. An example is the thermal insulation that significantly reduces energy losses of buildings (so-called thermal bridges), allowing to lower your energy consumption and improve the living comfort, simultaneously respecting the environment.
- *Use of renewable sources*: represents those forms of energy generated from sources that for their intrinsic characteristic regenerate or are not "exhaustible" in the "human" time scale and, by extension, the use of which does not affect the natural resources for future generations. They are therefore forms of energy that are alternative to traditional fossil fuels, and many of them are considered to be clean energy forms and do not object into the atmosphere harmful substances and/or GHG, such as CO_2 (Table 3.3).
- *Energy efficiency in buildings*: the definition of energy efficiency indicates that series of actions of programming, planning, design and construction will allow, for the same services offered, to consume less energy. When it refers to a urban system as a whole, it indicates the ability to guarantee a particular production process or the provision of a service through the use of the least amount of energy that is possible. The connection to a district heating network, the use of

Table 3.3 Local energy supply in Arquata: production of energy (electrical and thermal)

	Cogeneration (MWh)	Photovoltaic (MWh)
Electrical energy	4123	187
Thermal energy	4956	

Table 3.4 Local impact on energy demand (ATC building)

	Cogeneration (kWh/m^2/year)	Saving (%)
Heating	56.6	−25
Electrical energy	58.4	−10
Cooling	20	−25

Table 3.5 Impact of the policy project in Turin

Impact	Saving	%
Primary energy	−7786 MWh/year	−43
CO_2 emissions	−1997 tCO_2/year	−52

heat pumps or the connection of a cogeneration plants for heating and summer cooling of the houses are examples of energy efficiency (Table 3.4).

– Measurable impacts of the project on the Arquata district:

Sustainability

Policity project in Turin has had substantial impact with respect to previous situation in terms of primary energy savings and of CO_2 emissions reduction (Table 3.5).

Other impacts

The Polycity project is expected to produce also in future years economic and social benefits at different levels:

- Savings in energy costs (30–40 %) with respect to initial situation;
- Value increase of real estate due to efficiency improvements;
- Improved quality of life and services for the inhabitants (space heating, sanitary hot water, roads illumination, etc.);
- Information and education regarding sustainable services and consuming behaviours.

3.3.2.8 Running Projects and Recent Test Experiences

Cityteller project already exists since 2 years. It is a geo-emotional map that, through an *App*, chronicles the cities through books thanks to contributions from its users: Turin is one of the cities included in the project. The idea came to Lorena Petriccione and Fabrizio Parodi of Studioand [89] which has its headquarters in Turin and Albino (province of Bergamo). Cityteller comes from the concept of a storytelling: the ability to create emotional experience around any tale. The story is intended as a sharing of an experience, of an emotion. So it is a tool, a new "tourist

guide" mode to know the city through books and know the places of the books, providing a tool to watch and learn about the city through the story of its great writers. Literature, multimedia and sharing are the three key words that guide the user to his personal knowledge of an urban area.

Innovation and smartness affects all productive sectors in Turin: ICLEI for example has launched in 2014 the INNOCAT[31] project, procurement of eco-innovation in the catering sector through a European collaboration between public and private buyers who wish to procure products, services and eco innovative solutions in the catering sector. INNOCAT aims to bring together a group of public and private buyers to publish a series of tenders, for eco-innovative catering products, services and solutions. The aim is to help encourage eco-innovation in the catering sector by providing a sizeable launch market for new solutions [90].

INNOCAT will address environmental and social improvements in a range of fields, including:

- Transport;
- Waste re-use and recycling;
- Bio-based product;
- Energy-efficient equipment.

The existing buyers group includes a local authority, a central purchasing organization in the healthcare sector, a major international company, and an environmental business park. Purchasing sectors are likely to include:

- School catering services;
- Vending machines;
- Bio-waste disposal systems;
- Health and welfare catering services.

INNOCAT aims to recruit a wider group of public and private buyers to co-operate, and ideally participate in the development of tenders for these products and services. The project also aims to disseminate project results as broadly as possible and to promote an active experience exchange between buyers interested in eco-innovative catering. An online discussion forum will be established to facilitate this exchange.

ICLEI, Italian application of the European project, is seeking further public bodies and companies interested to follow the activities of the project, and potentially to participate directly in contract activities. Interested parties can join the "Project Interest Group". The specific areas included in the process are:

- Production, reuse and recycling of waste;
- Efficient low-consumption transport;
- Use of organic products;
- Equipment with high energy efficiency.

[31]INNOCAT began in March 2013 and will run for three years. It is supported by the European Commission's Competitiveness and Innovation Framework Programme (CIP).

And the types of products and services to be acquired have yet to be determined. It is likely that these will include:

- school catering services;
- energy efficiency vending machines.

The line of sustainable food and products understood as an overall process is more and more present in Europe[32] through innovatives projects: also the recent experience of Milan "EXPO 2015—Feeding the Planet/Energy for life" shows us this trend.

3.3.3 *Milano*[33]

Milan, capital of the metropolitan city and the Lombardy region, is the second Italian city (after Rome) for number of inhabitants, the thirteenth in the European Union and the nineteenth of the continent. To date, the city is the largest Italian financial market and ranks as the only Italian city in the list of World City Alfa.[34]

Milan occupies an area of 181.76 km^2 to the west of Lombardy, 25 km east of the Ticino River, 25 km west of the Adda, 35 km north of the Po and 50 km south of Como lake. From a climatic point of view because it is situated to the west of the basin of the Po Valley—the sea is quite far away—it has a semi-continental climate. According to the Köppen Climate Classification, Milan has a climate CFA (humid sub-tropical), i.e. temperate humid with hot summer. Like all big cities heavily inhabited, the city suffers from the "heat island" effect that makes temperatures inside the city higher than the surrounding countryside (with differences in winter even of 3 °C). The temperatures range between +1 and +5 °C in January to +20 and +29 °C in July, while the peripheral areas recorded lower average temperatures (around 1 °C). Winters are colder than those that occur in the coastal cities, while not reaching the peak of Central European cities. Summers instead, are characterized by a warm and very humid climate (due to poor ventilation caused also by the barrier generated by the Alps mountains). The rainfall in the Milan area are well distributed throughout the year, even though the winter season records relatively long periods without rainfalls with a minimum of about 40 mm in February, are also rainy intermediate seasons. The humidity and fog are two other climate phenomena that characterize the city of Milan (present in a particular way in the winter period and during the night). From an environmental point of view, the case of Milan does not stand out positively. In terms of air quality, the city remains the

[32]See Agropolis Munchen http://www.agropolis-muenchen.de/index_en.html.

[33]Population 1,331,715 (2014); area 181.67 kmq; population density 7330.41 inhab/kmq.

[34]The Alfa classification collects internationally famous cities (tourist, economic, business, etc.), due to their ability to influence global issues and to participate in international events of particular importance, for being a cosmopolitan city and center of international companies with own transport system and advanced and outstanding in the world telecommunications infrastructures.

most polluted city in Italy even if, compared to the values registered in 2012, the levels of nitrogen dioxide and those of PM10 and of benzene, have droppen down. As said before, the climatic condition of the city is favorable to atmospheric stagnation; the widespread dissemination of home chimneys of the heating systems that feed the exhaust fumes into the urban environment and the intensity of traffic helps to create a particularly critical condition in the atmosphere. In this regard, in recent years, measures aimed mainly to discourage the use of private vehicles (Congestion Charge, a morning stop fee, even in the suburbs, in addition to the new "C" area) have been taken.

Milan has won the OCSE prestigious Transport Achievement Award (2014) thanks to the actions involving the C[35] Area: the traffic in the central area was reduced by approximately 30 % (7 % in the rest of the city), it has occurred a drop of the parking demand of 10 % and an increase in productivity with regard to the goods delivery of 10 %. Also accidents hve been reduced by 26 % in the center, as well as pollutant emissions (PM10 −10 and −35 % CO_2) and both the speed of public transport (bus +6.9 % and +4, tram 1 %) and the use of low-emission vehicles (by 9.6–16.6 %) have increased.

Milan is at the top among European cities in terms of waste collection. In an overall picture of the Municipal waste reduction (−2.66 %), are 149 kilograms of differentiated waste/per inhabitant that are recovered, compared to 123 in Vienna, of 117 Monaco, of 105 Berlin and 76 in Paris.

Another record of the city[36] is that of the drinking water supply system efficiency. The drinking water in Milan (quite rare case) is supplied, with qualitative and quantitative results of excellent quality, exclusively by its groundwater. Instead for its disposal it was entrusted up to the threshold of the millennium, to flow into the irrigation system of medieval origin, practicing a kind of "biological treatment" *ante litteram*. Since 2005 however, a system of three purifiers in the southern part of the city, only releases treated and purified water with the limits laid down by national and european legislation. From a planning point of view, the city development could be called as an "onion", that developed in a manner that is circular and monocentric in different historical periods. Today Milan is the center of a big metropolitan area, the limits of which are not well defined; and it offers a number of continuity features with city centres or surroundings cities.

From the first decade of the new Millennium, the city is experiencing a profound architectural renewal process also from the urban point of view, the realization of numerous projects and interventions, aimed on the one hand to redevelop entire areas and large districts, and on the other to design a new urban image in Europe and the world (the new Fiera di Milano, Teatro alla Scala, urban fair and Project CityLife which includes three skyscrapers of more than 150 levels, the European

[35]The limited traffic area of the city.

[36]This paragraphs was developed using information included in http://it.wikipedia.org/wiki/Milano.

Library, Santa Giulia district, Garibaldi-Repubblica and Fashion Village), thanks also to international competitions attended by world reknown architects. All these projects and works have changed for event Expo 2015, and redesigned in the course of a few years the horizon profile of the City, which will no longer exclusively be marked by the Cathedral spiers, the Velasca Tower and the Pirelli Tower, but also from new and tallest skyscrapers. In 2012, for example, the Unicredit Tower with its 231 mt to the tip of the spire is was completed and it is the tallest habitable building in Italy.

3.3.3.1 Milano Smart City[37]

The path started to bring Milan to become a Smart City began in late 2011 with the participation in European call linked to Smart Cities and Communities initiatives.[38] Milan has participated, in partnership with the Milan Province, within 6 projects [91]. Of these, 4 proposals were funded in the smart city sectors: 3 projects on sustainable mobility sector (City Mobil 2, TIDE, Fr-Evue) and one on energy efficiency of public buildings (Eu-Gugle). In addition, there were two projects financed by Structural Fundings (2007–2013 POR) on info-digital islands and info-mobility for a total of EU contribution of about 2 and a half million euros.

Another project funded by the European Community through the Information and Communication Technologies Policy supported by the Seventh Framework Programme (2007–2013), named My Neighbourhood My City, refers to the overall theme of the Smart Cities and has a value of 167000 €, 80400 Euros of which derive from European co-funding. Behind this success it seems to be a protocol of close partnership between the City and the Chamber of Commerce, signed with the commitment to collaborate in research and social innovation, business and finance. Public-public partnerships (Milan City Council and Chamber of Commerce of Milan) also aims to create a dialogue with the territory and with the various stakeholders to share and carry on with the Milan Smart City project. To date, the city of Milan is an active member of the leading European and global networks that deal with Smart City, as Smart Cities Stakeholders Platform, C40 and Eurocities.[39]

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[37]The following paragraphs were developed on the basis of information available at: Municipality of Milan, Central Management Policies for Labor, Economic Development, University and Research; Sector Innovation Economy, Smart City and University; Smart City Service (2014), "Milano Smart City—Projects and major interventions", available at: www.milanosmartcity.org.

[38]Initiative sponsored by EU Commission as part of the Europe 2020 Strategy, in order to make more efficient and sustainable European cities from energy point of view, transport, information, communication technologies, economic development and social policies.

[39]EUROCITIES members represent 25 % of the EU's population. EUROCITIES is committed to work towards a common vision of a sustainable future in which all citizens can enjoy a good quality of life. The organisation provides a platform for its member cities to share knowledge, ideas and experiences, to analyse common problems and develop innovative solutions. EUROCITIES represents the interests of its members and engages in dialogue with the European institutions across a wide range of policy areas affecting cities, one of them being transport and

In 2013, Milan had a respectable position in the smart cities world ranking list: was in fact the first in Italy, and the forty-sixth out of 500 world cities.

3.3.3.2 Smart Mobility

The main goal of Smart mobility projects that the City of Milan has been carrying out in the last few years is to provide citizens means to easily move around: good availability of innovative and sustainable public transport with eco-friendly systems, regulation access to town centers in favor of greater livability and adoption of advanced mobility management and mobile information—also throught suitable apps and digital systems—to manage your daily commute of citizens and exchanges with neighboring areas.

As already mentioned, the Area C project[40] had the aim of reducing traffic flows within the Bastioni[41] area and make more rapid public transport, improving air quality. Area C is bordered by 43 gates with cameras, including 7 for the exclusive use of public transport system. The cameras detect the passage of each vehicle, only inbound, and transmit the data to a processor able to recognize the transport vehicles and relevant tariff. Access to Area C does not allow the use of dedicated lanes. The more restrictive provisions that regulate the ZTL and lanes reserved for public transport in the "Bastioni Area" remains in force and shall also be applyed to those who have paid the charge for access and circulation in Area C.

The vehicles allowed to travel in the reserved lanes are nevertheless subject to the discipline that regulates access to the Liited Traffic "Bastioni Area". Who needs to go to the Fatebenefratelli emergency hospital, located within the area, has free access through one of the access routes to the Area, in this case, the camera detects the input and output from the emergency area and then allows free access to the hospital, even for vehicles that could not enter the Area C. The vehicles entering through the same access and going towards the center are, however, subject to payment.

(Footnote 39 continued)

mobility. EUROCITIES connects over 2000 city officers across our 41 technical working groups, within 6 thematic forums: culture, economic development, environment, knowledge society, mobility and social affairs.

[40]Milan, as we have said, is the second largest city of Italy. As such, the city of Milan has a high traffic level, in which freight accounts for more than 4000 tons or 20,000 supplies delivered to retailers every day. In order to limit the potential disadvantages created by a high freight activity, the municipality of Milan has implemented a package of mobility solutions including a congestion charge area also known as 'area C' or 'Area Bastioni', which corresponds to the city-centre. Despite the efforts of the municipality and the introduction of the Area C, congestion remains an important issue in Milan. This has consequences in terms of air quality and traffic efficiency.

[41]The "Bastioni Area" identifies the central area of Milan, corresponding to the area bounded by ancient Spanish walls and occupying an area of 8.2 km^2 with a total area of 181 km^2 city.

Tied to the Area C project is the project TIDE (Transport Innovation Deployment for Europe). The project [92], started in October 2012 had a duration of 3 months and allowed the City of Milan to take part in a dialogue at European level on measures regarding urban mobility operated by several European municipalities. The purpose was to stimulate discussion and exchange of experiences on innovations in mobility; create a network of experts, providing to those who work within the cities and regions, a guide on how to implement successful concepts relating to technological transfer and replicability; work with the cities on possible implementation scenarios, etc.…

Another project carried out by the Municipality was based on the *traffic light preference* [93] for public transports in order to make more attractive for citizens the use the local public transport, reducing pollution, increasing speed and reducing the waiting time at traffic lights for public transport through the use of AVM[42] system and WiFi technology. The same technologies have also been used for the *Infopaline* project by which a number of digital panels were installed at the bus stops in order to improve the system of delivery of information to users on waiting times and possible changes in the routes. *Mobility portal* and *Infoalert* are two further projects also aiming at improving the information to customers and at limiting the vehicles traffic in certain hours.

Info-mobility for Milan is a project that implements a remote supervision and management of reserved parking areas for disabled people. The scope of the parking lots is also part of the project *Addressing the parking lots (App)*, which has developed variable message digital panels and a platform that collects information from the car park operators concerning the free parking spaces in the Bastioni area.

To encourage the use of electric vehicles the project *Digital Islands* has been also developed. It involved the construction of computerized areas of supply and charging of electric vehicles and provision of services with multimedia touchscreen as institutional information, SOS points, taxi, traffic information, WiFi, NFC[43] payment methods. Also with regard to heavy vehicles, Milan City Council has implemented various projects.

Among these *Fr-eVue* (Validating Freight Electric Vehicles In Urban Europe) has allowed to experiment a management model of urban transport systems of

[42]Authomatic Vehicle Monitoring (AVM) is a system that allows to monitor various data related to moving vehicles. In the local public transport sector within, also carries out the army from the vehicle tracking service. In any case the AVM is based on technology Automatic vehicle location (AVL), which is the sub system that takes care of teledetection of vehicles (typically by GPS).

[43]NFC, which stands for Near Field Communication, is a radio frequency connectivity technology that enables two-way short-range communication between electronic devices and thus only works at close range, up to a maximum of 10 cm. Really the interesting fact is that this technology can be integrated within the SIM, allowing telephone operators to enter the NFC services directly on the card itself. To make the payments, you will need a smartphone with NFC chip and the integration of credit cards (or prepaid cards) in mobile phone. To pay with your mobile phone, then, it serves on the one hand a smartphone designed and on the other a POS contactless also equipped with NFC chips. The two devices must be at 4 cm distance so that the transaction can be executed. http://www.pcself.com/guide/tecnolo-gie/nfc_pagare_con_il_cellulare.asp).

goods, applied to the supply chain of drugs, to reduce traffic, CO_2 emissions and noise pollution. It uses a proximity logistics platform with which vendors will give the medicines for internal pharmacies within the C Area. The loads destined to the shops within Area C will be routed through electric-powered vans to the platform and later limited emissions vehicles are used for the transport through the last mile, from the proximity platform to the shops [94].

Other projects are developed to rationalize freight transportation through the implementation of loading/unloading areas. A technological system to detect if the place is busy or not, recognizing the parked vehicle, as well as, for dangerous goods, control the transport with a remote control and management system, by which the routes can be defined according to times, sensitive targets and of further dangerous goods along the urban network.

The BikeMi [95] project instead had meant to encourage cycling mobility by offering a bike-sharing service managed through a dedicated web portal and mobile software. In the same way, the project *GuidaMi* has implemented a car sharing system managed through online (or through the call center) registration and booking systems.

3.3.3.3 Smart Economy

The actions that the City of Milan has put in place in the field of smart economy were referred to stimulate and promote the system consisting of private enterprise, government agencies and research institutes. Other initiatives were aimed at harmonizing and promoting virtuous businesses and raise the general level of technology to create a stimulating environment for the ICT business.

For this purpose the following projects have been developed: Ticketing & Payment project, which through the use of NFC[44] technology allows to purchase and validate tickets for public transport company ATM directly by mobile phone; the project Making Business and Iris which developed an interactive portal and computer systems that allow to carry out the instruction of online practices by simplifying bureaucracy related to opening, closing or change of productive activities (artisanal, commercial, industrial).

3.3.3.4 Smart People

The City of Milan is convinced that the smart city is based on a new awareness and participation of citizens in public life.

The projects in this area are intended to stimulate the peaceful coexistence of different stakeholders, the status of citizens and the interaction and ongoing dialogue to detect the concrete needs and make efficient and effective their response.

[44]XXXX.

The following are some of the projects that the Public Authority Council has continued to pursue. The LIA Project (Libro Italiano Accessibile) is an interesting project that aims to make accessible to blinds and visually impaired people, thanks to technology, 3000 of books. The project, coordinated by IEA-Italian Publishers Association which joins the City of Milan, was funded by the Ministry of Heritage and Culture and allowed to create a online Media Library in which speech synthesizers and some MP3 format texts are available. The goal is to break down cultural barriers between citizens. In the field of accessible culture also the *Autoprestito RFID* project and the project *ReadIt* (App) have been put in place. The first provides for the automation of the municipal library services with direct and therefore independent access, from readers, the loan and the return of books, while the second allows for consultation of the catalog of public libraries via an application to be installed on mobiles.

In the social cohesion development sector, the European project *My Neighborhood, My City* [95] ended last year (2015), with an EU contribution of €80,400. For Milan, the selected district for testing the project was Quartoggiaro[45] with the goal of connecting people, ideas and resources as a strategic function for social innovation processes. The open innovation approach through Living Lab[46] experiences, born from citizens regenerates the area through the use of new technologies. Another project is the *Crowdfunding Platform*. The aim is to develop a platform that strengthens the connection between public, private and social enterprises to facilitate the procurement of resources, the financing of social initiatives and social community projects for the Milan area. A Website linked to the City Council website was specifically designed to highlight projects that private (individuals or group) may decide to finance by making individual donations (crowdfunding method). The City Council selects worthy projects, while a partner ensures telematics supports. The purpose is to get fundings for social activities.

To improve accessibility to the Municipality resources, thanks to the systematization of estate resources in the municipal network, the Agenzia UNI[47] project was developed by which the Milan Municipality. It had set up an agency to facilitate the matching of residentiality (supply/demand), contacting property owners and university students to facilitate in finding accommodation to be shared.

In the field of neighborhood safety, the *Ambrogio project* has been developed. The project provides the opportunity for citizens to make reports at the

[45]My Neighbourhood My City my city project is co-financed by UE within the Information and Communication Technologies Policy Support Programme.

[46]Living Lab means an environment for testing new technologies (products, services) in real conditions, in a defined geographical area and for a limited period of time, with the aim to test the performance and feasibility for end-users (citizens, business people, consumers, public authorities, etc.). Within a Living Lab are triggered co-planning processes with service users when they are still under development: such cooperation between private and public actors (Universities, Public Authorities, Companies, etc.) allows a continuous improvement of technical specifications and performance of the tested services. http://www.ao.camcom.it/alcotra-innovazione.aspx.

[47]http://www.agenziauni.comune.milano.it/dccasa-front/home.html.

district-policeman, which through a special device will report to the relevant departments. The information system allows for immediate deployment and a fast response.

Finally, it is worth mentioning the *More involved and Safer Elderly people project*. It is a personal care programme carried out by social and health services operators and volunteers, which, together with elderly people, have designed suitable support tools that can be a useful aid in everyday life and during medical emergencies. The goal of the project is the raise the perceived mental and physical feeling of security of the elderly people, so as to let them stay at home, reducing the cost of improper access to Hospitals. The project started thanks to a digital application, the APP "The mobile-phone, your life-saving."

3.3.3.5 Smart Living

Starting from its own history and identity, the administration of the city of Milan has promoted, through some projects, its touristic image with a massive web-based presence, virtualizing cultural heritage and traditions, and creating a network around the "common good" of the city of Milan for citizens and visitors. Technology has allowed us to use advanced techniques to create paths and mappings of the city and to make them easily accessible.

The following are some of the projects implemented in this field. A free App has been developed within the MET project (Extended Museum in the Territory). The App offers access in 5 languages with geolocation of public/private museums based on three selection criteria: proximity, price and opening time. The DigitaMI project promotes culture and identity of Milan through the publication of contents on the Digital Library of the city. Finally, the Project Eventi App allows citizens, tourists and city users immediate consultation of the events organized in the city area, through mobile devices or PC.

3.3.3.6 Smart Governance

The City Council has decided to engage citizens in issues of public importance, promoting awareness-raising and using technologies to digitize and reduce administrative procedures. It promotes transparency in government procedures and the opening and sharing of data streams (Open Data).

A European project, Smart Ciber (Integrated Map of the anti-terrorism risks), aims to create a mapping system for the prevention of risks in the security and safety areas during major events. Thanks to a European grant of 167656.93 Euros, Milan has set up a database and a geo-referenced map to find attractors of risk (public bodies buildings, hospitals, etc.) and assess the degree of risk of each of

them, in order to increase urban security with the goal of building emergency plans in the event of a terrorist attack (for example in the Expo period).

In the area of efficiency and smart governance, the Simplifies-MI project sees the cooperation between judicial Offices and the Municipality. It allows the transmission, from the Court to the Municipality, of criminal certificates and the court's decisions that have to be reported to the local Registry Office. The project brings tangible results for citizens, who avoid waiting behind the doors and can rely on certain deadlines for documents delivery. Even for the Administration, the effects are considerable in terms of savings and speed in transfer of documents.

Similar is the ICARUS (Interoperable Infrastructure and Cooperation Application in the Hospital for Birth Registration Services) project, funded by the Lombardia Region with 55000 Euros. The project developed a computer procedure, active since 2010, which allows the delivery of a range of services related to the registration of births in the hospitals. The procedure allows making the declaration of birth, asking the tax code and making the choice of a pediatrician at the hospital where the birth took place. All at the same time, preventing the parent to go to the Municipality Department, the Revenue Agency and the Local Health Unit.

Parents on Video is a project (launched in 2013) sponsored by the Milan City Council and Italia Microsoft that promotes a greater presence of parents in the school life of their children. Regardless of geographic distance and work schedules, it allows to save time by attending school meetings remotely.

Within this context have been developed projects related to the digitization of Territorial Plans of the Municipality (PGT and NIL projects). In the Territorial Plan of Government (PGT), 88 areas have been identified. They allow to outline a clear graphical map for each urban area. The objective is to identify missing and/or unefficient services for each area, so as to implement a Municipal Service Plan from actual needs of citizens. This analitical tool allows implementing at neighborhood scale a monitoring system of services and needs, allowing a continuous dialogue with citizens.

3.3.3.7 Smart Environment

In this area some projects aim to achieve an environmentally sustainable development, a reduction of the amount of waste through re-cycling, a reduction of greenhouse gas emissions by limiting vehicles traffic and optimizing industrial emissions. These goals are added the rationalization of the building constructions and the consequent reduction of the impact of heating and air conditioning, public lighting rationalization, promotion, protection and management of urban green and reclamation of brownfield sites.

The objective has been achieved through: the *Smart Spaces* project (with a European contribution of EUR 39084.80). The project has developed a system to support decisions in the energy sector and the creation of a service for the

management of energy in public buildings. The Eu Gugle project (European contribution of 250900 euro), has put in place an energy requalification campaign, starting from public buildings energy refurbishment, sustainable mobility with the involvement of citizens.

Another highlight is the *Intelligent Trash* project (2010) with the aim of optimizing the number of vehicles for the collection of waste, resulting in reducing environmental impact and optimizing urban mobility thanks to information provided by "smart" trash, equipped with microchips and integrated GPS systems. Infact they can alert the Operational Centre of the EMSC (Environmental Milan Service Company which manages the integrated cycle of waste, street cleaning and other essential services of the City) when the trash bin is full, moved or damaged. Int his way the bins are emptied and put back in place, as soon as it possible.

In the field of public lighting the SMART IP project, for efficient public lighting, operates in real time 130000 points of light with a saving of 15 %.

In the field of infrastructures instead the project *District Heating* since 2013 has enabled the expansion of the district heating network of 700 cubic metres thanks to the connection to the A2A[48] network [96].

3.3.3.8 The Milan Expo 2015 and the First Green Field European Smart City

The Milan Expo 2015 [97] has been a real test experience for the implementation of the first green field European Smart City; that is also the first district in Europe—built from scratch—in a smart way. It is thus likely to activate positive effects on the whole territory. The Chamber of Commerce together with the most important trade associations (Confcommercio, Confindustria, Assolombarda and Milan Union) had, already in 2013, created the Milan Expo Ecosystem project for the city activities, the first digital application to improve visitors hosting, the Milan attractiveness and quality of life of citizens.

The subject of Expo 2015 was that of the food supply (Feeding the Planet, Energy for Life). Such theme was declined in a technological perspective. The other aspect related is that the event took place on an area of 1 million m^2, which every day has hosted about 150000 people. A medium sized Italian city, who has lived only for 6 months, but which had the opportunity to be organized in a smart way.

From this point of view, the Expo has constituted a test of what in the future the city of Milan will be able to offer to all citizens. A Digital Smart City where its visitors were real time users and main actors: through a path built on several levels, for example, it was possible to incorporate real and virtual experiences, walking

[48]Company of public utility services, such as the production and sale of electricity in Milan.

throught the halls and seeing performances, pointing the smartphone on specifical areas and receiving real-time additional information.

The "Smart" design of the Expo was carried out with various partners including Telecom, Enel, Cisco, Accenture. By this collaboration a lot of initiatives have been started: from the infrastructural point of view, for example, it was decided to use recyclable materials, to intervene on the electrical infrastructure for increasing its efficiency. For example, Enel Company has tested an innovative electrical substation and a prototype of efficient lighting systems; Cisco brought and installed ultra-broadband, with a large Wi-Fi coverage throughout the city (Digital Smart City), also based on cloud services was developed.

Digital technologies have accompanied the visitor to improve his personal experience: dedicated services, delivered through multimedia totems or on smartphone. These have made orientation easier, avoiding queues and offering personalized itineraries according to the specific interests and expectations.

Experiencing the Smart City concept was not be limited to the Exhibition Site, but continued outside allowing visitors to move independently and to explore the city, by providing information on tourist routes and facilities, transport, etc. One of the major projects that has been "inherited" from the Expo 2015 initiative, and that is within the smart economy projects, is the project *E015 Digital Ecosystem* [97], which consists in the creation of an "Ecosystem of Interoperable Services", i.e. an open community of providers of services and applications, that take a technological reference model for data sharing in order to enrich a range of applications for end users. E015 Digital Ecosystem is a Digital Open cooperative environment, non-discriminatory and competitive for the development of integrated software applications and services, through which each subscriber (company, organization, association, …) can make available their own information content for software solutions for its end users. Through the project the whole city has had the availability of services, applications and glossaries "built" in cooperation between different companies, organizations and associations; an asset for the Lombardy Region, both locally and nationally; a new model of collaboration between different organizations and companies. Among the services that have been offered within the Digital Smart Cities, there are the digital technologies offered by Cisco Company. These services have transformed Milan into a broadband city. The Expo 2015 visitors, in fact, thanks to Cisco have experienced health services in a digital city. The Cisco Health Presence, was applied through stations that have allowed remote medical care. The device was connected to allow paying the remote health service with the help of a large screen and a high definition audio service. In this way, it was possible to connect the patient with the doctor for a visit at all "digital".

The EnergyWise project implements the service that has measured the expenditure of energy of all devices. By monitoring better energy efficiency can be ensured so as to reduce waste and to respect the sustainability policies that have been main actors of Expo 2015. Accenture was responsible for providing digital services including the official Milan Expo App 2015, which has offered exclusive

contents about the Milan Universal Exposure. The app that allowed users to manage a personal profile from which it was possible to plan their visit to Expo, buying entrance tickets and building a personalized agenda of events. This application provided the interactive map of the exhibition site with warnings to visitors and real-time information, selected and based on the location of the visitor, a calendar of scheduled events and daily updates.

3.3.3.9 Ongoing Projects and Recent Experiments

In August 2014, the City of Milan has signed 14 projects to kick off a financing line of 93 million Euros by the Ministry of Education and the Lombardy Region [98]. The race towards a more sustainable, interactive, accessible and inclusive city doesn't stop. Projects range in various areas:

The "SCHOOL-Sustainable Campuses as Urban Open-Lab Areas" project has as main goal the testing of an advanced school system that is able to integrate, in an intelligent and coordinated way, various aspects related to the smart grids issue based on renewables based generation systems and on energy efficiency from a thermal/electrical point of view.

Some of the objectives are: to study, install and test innovative photovoltaic systems with the possibility to integrate electric storage and thermal systems for buildings within the University Campus, on public buildings and on households; to study and develop innovative charging systems for electric vehicles; to monitor and manage throught intelligent devices, located in secondary substations, the network resources by coordinating the production of energy by the innovative PV systems, and in general the Distributed Generation and the energy required by the loads; to analyze the positive effects on the network of the NZEB "Nearly Zero Energy Buildings".

The project *SIMULATOR* (Modular Integrated System for the risk management) aims to implement a Decision Support System, based on ICT technologies and designed for the protection and safety measures of the territory. It is an integrated modular system based on new technologies and methods for prevention, forecasting, monitoring and real-time management of risks due to anthropogenic (due to technological accidents, chemicals/industrial, roadway accidents) or natural causes (predominantly due to meteorological and seismic nature of extreme events).

The E-WASTE project aims to strengthen and optimize the entire process connected to re-cycling of the Waste Electrical and Electronic Equipment in order to recover precious materials through a pilot process based on a network of small and medium-sized companies (from the Milan hinterland).

Another goal is to strengthen collaborative actions among public and private organizations operating in the recycling sector: the main objective is to creaye, in

the all the italian regions, a critical mass so as to give each region the possibility to compare and share experiences. The project follows the institutional objectives of the Milan City Council to increase the collection and recycling of waste and its optimization and control while minimizing illegal activities related to waste, especially considering the type of waste, treated by the project. The project also has potential impacts on economy creating new jobs opportunity and supporting local companies in crisis.

The Playful project aims to harness information and communication technologies to provide advanced tools for integration and development of communication skills of children in pre-school age. The aim is to provide each child and his family customized tools, both to allow the child to learn better and, if necessary, to follow specific therapies, as well as to allow families to interact with the context (school) and among them.

3.4 Asia

3.4.1 A Smart City Horizon in China[49]

To reflect on environment means to reflect on history, so the progress of technology, the digital information revolution and the spread of mass communication with the great changes in the economic, financial and geopolitical and global rebalance call for a new approach to the city and new visions related to the urban environment.

Our knowledge of the city and its complexity needs to evolve in line with the growing importance of the cities all over the world.

Chinese cities are megacities that are re-invented every day by their residents, commuters, immigrants, civil society groups, planners, politicians, businesses, investors and visitors who bring with them their own identity, aspirations and demands for better urban quality. These "ideas of the city" developed in Asia transcend all conventional disciplines [99].

It is estimated that China's urban population will grow from 527 million in 2005 to 926 million in 2025 [100]. Cities with a population exceeding 1 million are likely to increase from 153 to 226 in that same period. In 2011 the Chinese National Bureau of Statistics also announced that China's urbanization rate had surpassed 50 percent.

[49]By Ina Macaione, Professor at Dipartimento Culture Europee e del Mediterraneo: Archiettura, Ambiente, Patrimoni Culturali (DICEM), University of Basilicata, Matera, Italy . ina.-macaione@unibas.it and Enrico Anello, PhD student, Dipartimento Culture Europee e del Mediterraneo: Archiettura, Ambiente, Patrimoni Culturali (DICEM), University of Basilicata, Matera, Italy enrico.anello@unibas.it.

In a recent article written on National Geographic Robert Kunzig states that smart cities could be the solution for our growing environmental and social pains [101]. As a matter of fact, high density cities tend to emit less greenhouse gas emissions than the national average. It is particularly true for the United States, consuming 25 tons of CO_2 equivalents per person on average compared to 10 tons in New York City. It is not the case for China, consuming 4 tons per person on average compared to 11 tons in Beijing.

China is experiencing an important phase of urbanization. Annualy, twelve million Chinese people move from rural to urban areas. That is equivalent to a new city of the size of Beijing every year.[50] As a result, China has taken the lead in terms of cities with over one million inhabitants: 89 in China, 46 in India and 42 in US. However, this puts a lot of pressure on providing basic food and water services. If designing smarter cities makes sense, leaving rural development behind does not appear as a sustainable proposition.

Residential and industrial water usage, mainly in urban areas, represents 36 % of the consumption of fresh water reserves in China. In comparison, agriculture in rural areas accounts for 62 %. And the Chinese agriculture sector is challenged to meet an increasing food demand related to a higher standard of living in modern cities. With 90 % of its water reserves already in use, China is facing a complex water and urbanization nexus that cannot be considered without its impact on the rest of the country.

So among the priority objectives of the People Republic, to be achieved by 2020, expressed in the context of the XVIII National Congress, is to identify strategies for the definition of new models of development, specifically Chinese, on industrialization, informatization and urbanization issues, and above all the modernization of agricultural production, also using the principles expressed by the green economy. Within the same document of the XVIII Congress it has been underlined the concept of an "ecological civilization" that should be integrated in the whole process of urbanization, as expressed in the idea of Smart City, especially to solve the serious pollution problems. That is why, in China, Smart City is a model not only for strengthening urban planning, construction, maintenance, intelligent management services, promoting the sustainable operation of metropolitan areas through the integration of information resources and technologies, but also to give an economic model in the global market.

– As reported in the EU-China Smart and Green City Cooperation "Comparative Study of Smart Cities in Europe and China"—White Paper, the urbanization process has accelerated in China, particularly during the past 10 years with the urbanization rate reaching 52.6 % in 2012. As reported it must be noted that

[50]In 2013, the Chinese capital has exceeded twenty million inhabitants. It is estimated that the population is around 24 million.

urbanization is part of China's modernization process which provides a substantial latency for enlarging the domestic economy.
– The Structural hierarchy of the administrative divisions of the People's Republic of China comprises of 5 levels: Provincial, Prefecture, County, Township and Village. At present, the relevant government departments and various cities in China are positively promoting smart city development.[51]

In the year 2012 the Ministry of Housing and Urban-Rural Development (MoHURD), of the People's Republic of China, launched the programme China Smart City [102]. The core of the operation regards the "smart" urban management together with the implementation of the new urbanization strategies and business requirements. The construction, safe operation, urban management, and convenient service of smart city and municipal infrastructure should be combined to realize managing cities and serving the public in a smart way, so to explore a new urbanization progression mode. To gain this success the MoHURD has identified 193 cities in 2012 and 2013 in total, which include 76 provincial capital cities/prefecture-level cities, 75 county-level cities, 34 new districts, and 8 towns.

There are about 2600 projects that have already been approved, with a planned investment of over one trillion RMB. The government funding and bank loans represent the 50 % of the investment. The economic and political equilibrium requires private investment, including international ones. According to "National

[51]Hereby a short description on the achievements by the single departments: Ministry of Industry and Information Technology (MIIT), Since 2011, MIIT has formulated a number of plans associated with smart city development, including • The 12th Five-year Plan for the Development of Information Security Industry • The 12th Five-year Plan for the Development of Internet of Things • The 12th Five-year Plan for the Development of E-commerce; National Development and Reform Commission (NDRC), NDRC and MIIT, together with the Ministry of Science and Technology, the Ministry of Public Security, the Ministry of Finance, the Ministry of Land and Resources, MOHURD and the Ministry of Transport, are studying to draft Guiding Opinions on Promoting the Healthy Development of Smart Cities. The Opinions proposes to start smart transport, smart grids, smart water supplies, smart environmental protection, smart medical care, smart old age security, smart communities, smart homes, smart education, smart land administration, smart logistics and smart credit systems in order to provide enterprises and residents with more convenient, efficient and low-cost social services. The Opinions also proposes to select 100 cities of different sizes at different stages of development in the eastern, central and western regions as pilot and demonstrative cities for smart city development. After some experience has been acquired from the pilot and demonstrative cities, China will gradually encourage and support eligible regions to promote smart city development according to local conditions; The Ministry of Housing and Urban-Rural Development ("MOHURD"),The General Office of MOHURD officially released in 2012 the Notice on Carrying out National Pilot Smart Cities and issued the Interim Measures for the Administration of 11National Smart Cities and the Pilot Index System for National Smart Cities (District and Towns) (for Trial Implementation) to start the application for pilot cities. In addition, the Chinese Society for Urban Studies and China Development Bank have signed the Strategic Cooperation Agreement on the 12th Five-year Plan for Smart City Development, which requires that China Development Bank should provide an investment and financing amount of no less than 80 billion Yuan in 3 years after the 12th Five-year Plan Period to support smart city development in China which clearly proposes to develop pilot and demonstrative smart cities where conditions permit.

Smart City Pilots Index System" developed by MoHURD, the overall design of "smart governance and service" includes: the renewal of the "security system and infrastructure" (areas that absorb the bulk of the investment), urban governance, an innovative urban and rural planning, achieving a good level of energy efficiency and industrial development.

The China Smart City project fielded by the Chinese government is a systematic and immense project and for its implementation it will require resources of any kind and a process of wide participation.

The MoHURD coined the slogan "Government Guidance, Market Leading, Multiple Subjects, Global Participation". To ensure the best functioning, the MoHURD has specially set up the Digital City Engineering Research Center of Chinese Society for Urban Studies, as the main center for promoting and guiding the development of China Smart City.[52]

The China Smart City project—strongly supported by the Chinese government—has generated the activation experiments that invest the entire Republic with major economic achievements and investments in many regions and cities, as well as those pilot selected by the MoHURD, for governance, transport, security, health, social problems, education, construction etc. This process is giving a further acceleration to changes in Chinese society and that will have world wide influence.

3.4.1.1 China Climate Change

On 30 June 2015, China submitted its Intended Nationally Determined Contribution (INDC), including the target to peak CO_2 emissions by 2030 at the latest, lower the carbon intensity of GDP by 60 to 65 % below 2005 levels by 2030, increase the share of non-fossil energy carriers of the total primary energy supply to around 20 % by that time, and increase its forest stock volume by 4.5 billion cubic metres, compared to 2005 levels. The emission levels estimated for 2025 and 2030 resulting from all aspects of the INDC, except the carbon intensity target, are rated medium. However, the emissions resulting from the 2030 carbon intensity targets if taken in isolation are significantly higher and would be rated as "Inadequate." The weak INDC carbon intensity targets would only be reached at the expense of important national policies and actions, including in relation to reduced air pollution. This means China's INDC (and its national actions) are not consistent with limiting

[52]The Digital City Engineering Research Center is also developing investment models and innovative ways to attract international investments. The boom of Smart City projects in China has a huge market potential for technology and foreign capital. One can imagine that there will be great demand for advanced foreign technologies and foreign funds. According to Gartner and other consulting firms, implementation of Smart City projects in China is a growing trend. However, the Chinese government is cautious about working with foreign companies for reasons of financial security and information ser-vices. Who will invest in the Chinese market, however, you will need to put in place a sophisticated strategies to build trust with the various levels of the Chinese government (source PRNewswire, March 2014).

warming to below 2 °C unless other countries make much deeper reductions and comparably greater effort than China. Setting aside the carbon intensity target, China's INDC's actions and non-fossil energy target lead to greenhouse gas (GHG) emission levels of around 13.6 $GtCO_2e$ in 2030 and to an improvement of carbon intensity of 70 %. China is implementing significant policies to address climate change, most recently aiming to restrict coal consumption. However, total GHG emissions are likely to continue increasing until 2030, as China has not yet implemented sufficient policies addressing non-CO_2 GHG emissions (methane, nitrous oxide, HFCs etc.). This indicates a need for further action in this area, and it is encouraging that the INDC acknowledges that addressing these gases is important. An issue of significant concern, with Chinese emissions still far from a 2 °C pathway in 2030, is the time span of the INDC commitment. As with other countries, the 2030 time-frame could effectively lock-in warming above 2 °C based on the current levels of ambition.

The announcement that China will peak its CO_2 emissions will have a significant impact on global CO_2 emissions in the period after 2030, as most projections foresee increasing emissions for decades after that. As the target consists of changes in the energy mix, additional energy efficiency measures reducing the absolute energy use could decrease emissions even further [103].

In November 2015 a report by The National Development and Reform Commission on "China's Policies and Actions on Climate Change" states that "Climate change is a common challenge facing human society today. As the largest developing country with a large population, China has complex and diverse terrain conditions, faces unbalanced, uncoordinated and unsustainable problems in the economic development, and is vulnerable to the adverse effects of climate change". Since 2014, China has actively taken measures in various fields to tackle climate change and achieved remarkable outcomes. China issued the National Climate Change Plan (2014–2020) putting forward China's main objectives and key tasks to address climate change before 2020. China submitted the Intended Nationally Determined Contribution (INDC) to the Secretariat of United Nations Framework Convention on Climate Change (UNFCCC). By adjusting industrial structure, improving energy conservation and energy efficiency, optimizing energy structure, controlling non-energy GHG emissions and increasing forest carbon sinks and taking other efforts to control GHG emissions, China lowered its carbon dioxide emissions per unit of GDP by 6.1 % in 2014, with a cumulative decline of 15.8 % over 2010, completing 92.3 % of its carbon intensity decline target during the 12th Five-Year Plan period. At the same time, China actively promoted international exchanges and cooperation on climate change, issued joint statements on climate change with India, Brazil, UK, EU, US and France and prepared South-South Cooperation Fund for climate change; it actively participated in international negotiations on climate change in a constructive manner for 2015 Paris Agreement and follow-up system construction. This annual report has been issued to help the comprehensive understanding of China's policies and actions on climate change, and the progress made since 2014 [104].

As officially released by the Ministry of Science and Technology (MOST) the authoritative and comprehensive report on climate change and its impacts in China, shows that annual average air temperature of China has increased by 0.9–1.5 °C during the past century since 1909, which was larger than the average global temperature rise. The rate of sea level rise along China's coasts from 1980 to 2012 was 2.9 mm/a, higher than the global average. The glaciers in China have retreated, and the trend is accelerating. From 1970s to this early century, the area of glaciers and frozen earth have shrunk 10.1 and 18.6 %, respectively. The trend of regional climate warming in China will further intensify in the future, and temperatures are projected to rise another 1.3 to 5 in most areas of China by the end of this century. This report is the result of a more than 3-year analytical effort by a team of over 500 experts from MOST, China Meteorological Administration (CMA) and Chinese Academy of Sciences (CAS), Chinese Academy of Engineering (CAE). The 42-chapter National Climate Assessment assesses the science of climate change and its impacts across China, now and throughout this century. It documents climate change related impacts and responses for various sectors and regions, with the goal of better informing public and private decision-making at all levels.

China's goals to cut emissions from its coal power plants by 60 % by 2020, announced by Chinese government during the world Paris Climate Conference (COP21) will become an initiative that would help save some 100 million tons of raw coal and prevent the discharge of about 180 million tons of CO_2 each year, according to an official communiqué quoted by the New China Press Agency.

But China is still struggling with fossil fuels: more than 70 % of Chinese electricity is generated from coal, of which the Asian giant consumed 4.2 billion tons in 2013. China, which is the biggest coal producer and consumer in the world, moreover recently acknowledged that it had massively underestimated its consumption and in recent years had burnt hundreds of millions of tons more than initially announced. China, which is the second-largest global economy and the world's biggest polluter, pledged that its CO_2 emissions would peak "around 2030". China's Basic Position on the Paris 2015 UN Climate Change Conference is to strengthen actions on climate change after 2020. China is willing to work actively and constructively with all parties to promote negotiating process under the principles of "common but differentiated responsibilities", equity and respective capabilities so as to ensure to reach agreement and build an equitable and justified international climate arrangement [105].

3.4.1.2 Airpocalypse—Red Alert

In response to the above premises and intentions, on Monday 7 December 2015 Beijing has issued its first pollution red alert as smog had engulfed the capital with millions of vehicles forced off the roads, factories and construction sites shut down and schools and nurseries advised to close. The notice, issued after days of heavy smog imposed restrictions on certain types of vehicles in the city of 22.5 million people and Chinese authorities faced fierce criticism.

AS reported by BBC News at 07:00 local time on Tuesday (23:00 GMT on Monday), when the alert came into effect, the US Embassy's air pollution monitor in Beijing reported that the intensity of the tiny particles known as PM 2.5 was at 291 micrograms per cubic metre producing.

By 11:00 it had dropped very slightly to 250—still a level described as "very unhealthy". Levels of the poisonous particles in the suburbs were reported at several times that number for which "The World Health Organization" recommends 25 micrograms per cubic metre as the maximum safe level. This mens that the quantity of dangerous particulate matter (PM 2.5) surged to around 40 times the World Health Organisation's maximum guideline. Coal-powered industries and heating systems, as well as vehicle emissions and dust from construction sites, all contribute to the smog which has been exacerbated by humidity and a lack of wind [106].

Greenpeace complained that the government's insufficient alerting system compounded the effects of Beijing's latest "airpocalypse", in which readings of the hazardous airborne particle PM2.5 exceed 900 micrograms per cubic metre in some parts of the city. China's leadership has vowed to crack down on environmental degradation, including the air pollution that blankets many major cities, following decades of unbridled economic growth. The move comes as U.N. Secretary-General Ban Ki-moon warned a Paris summit of nearly 200 nations against a "climate catastrophe", urging governments to reach a strong deal to limit global warming. The warning was an upgrade from an orange alert issued over the weekend, part of China's four-color warning system that includes yellow and blue levels for less polluted conditions. Environmental Protection Minister Chen Jining on Sunday vowed to punish agencies and officials for any failure to quickly implement a pollution emergency response plan, the state-run Global Times tabloid [107].

Last year the Chinese premier, Li Keqiang, vowed to declare war on pollution, but despite such pledges smog continues to blight cities right across the country. Scientists blame air pollution for about 4000 deaths a day. Ma Jun, director of the Institute of Public an Environmental Affairs in Beijing, said that the capital first red alert underlined how serious the smog problem remained. "It just shows that air pollution is still a very big challenge to the city of Beijing and that the government has paid greater attention to this issue," he said. Ma Jun said it would have been a "very tough decision" for China's leaders to declare the red alert in a city of about 23 million inhabitants.

The crisis is even more severe in the regions surrounding Beijing, where 100 of millions of tons of coal are still being burned each year even as the capital tries to slash its use of the fossil fuel [108].

3.4.1.3 Shenzhen as a Pilot Low Carbon Eco-City

In the geography of globalization and Delta dreams we can assume that the cities of Asia have indeed come to dominate the world becoming global, with their infrastructure, [109] and their global level associated with globalization have contributed to a demand for new forms of territorial centralization of top-level management and control functions, but its agreeable the reflection that "the most important thing enabling these cities to enjoy their success is the people who call them home".[53]

The big question now facing China is that it is a prosperous country with a rapid economic growth that faces at the same time a deteriorated social and ecological environment.

The Shenzhen 2015 Bi-City Biennale of Urbanism/Architecture (UABBA) has been titled "Re-living the City", which in the official catalogue concerns re-use and recycling of the city fabric, as well as "the return of memory": looking back to origins, drawing on existing and past conditions before looking to the future [110].

To better understand the diversity, innovation and adaptability of the Chinese model it could be useful to take a particular example in which one of the declination of the Smart City concerns the food urbanism.

Shenzhen is one of the districts "laboratory" of the program China Smart City.[54] Among the various actions the municipality has integrated agriculture within the urban environment.

Originally Shenzhen was a fishing village, and after more than three decades of reform and opening up, it has developed into a modern metropolis, becoming an icon of the reform, the representation of the "opening of China towards the building of a more modern country".

Shenzhen the first Special Economic Zone (SEZ) in China is located in the southern part of Guangdong, facing the Daya Bay to the east, Pearl River Estuary to the west, and Hong Kong Special Administrative Region (SAR) to the south. In 2012, with an area of 2050 km^2 the city had a permanent population of 10.54 million and its GDP, reaching 1.295 billion RMB, it ranked fourth among the first cities in China.

Shenzhen (Chinese: 深圳) is part of a paradigm shift in the construction and adaptation of new urban forms. Cities like Shenzhen are the face of urbanization in the 21st century. Shenzhen's Special Economic Zone (SEZ) was originally developed as an area for trade and industry, dominated by factories, warehouses and dormitories, fed by foreign investment. Shenzhen grew rapidly in and around the SEZ to become a dense urban fabric. As Shenzhen's skyline has filled with skyscrapers, its business districts and high-end residential areas have continuously evolved, replacing existing parts of the city.

It currently also holds sub-provincial administrative status, with powers slightly less than a province. According to the Government report for 2014, Shenzhen had a

[53]Ibid, 330.

[54]The second smart city was closed at Shenzen on September 3rd 2015 Convention & Exhibition center with great success.

population of 10,628,900 and a metropolitan area population of over 18 million Shenzhen's modern cityscape is the result of its vibrant economy made possible by rapid foreign investment since the institution of the policy of "reform and opening" establishment of the SEZ in late 1979, before which it was only a market town called Sham Chun Hui (深圳墟, literally Shenzhen Market) which the Kowloon-Canton Railway passes through. Significant sums of finance have been invested into the SEZ by both Chinese citizens and foreign nationals. More than US $30 billion in foreign investment has gone into both foreign-owned and joint ventures, at first mainly in manufacturing but more recently in the service industries as well. Shenzhen was one of the fastest-growing cities in the world during the 1990s and the 2000s with a breathtaking growth its urbanization pace is unique. It's population boom slowed down to less than one percent per year by 2013 as the manufacturing boom ebbed in favor of other industries. Shenzhen is a major financial center in southern China. The city is home to the Shenzhen Stock Exchange as well as the headquarters of numerous high-tech companies. It was dubbed as China's Silicon Valley due to this high concentration of technology companies. Shenzhen ranks 22nd in the 2015 edition of the Global Financial Centres Index published by the Z/Yen Group and Qatar Financial Centre Authority. It also has one of the busiest container ports in the world. In 2007, Shenzhen was named one of China's ten most livable cities by Chinese Cities Brand Value Report [111].

Today's Shenzhen consists of six districts, Yantian, Luohu, Futian, Nanshan, Bao'an and Longgang. The former four districts are located within the SEZ which occupies 329 km^2. And the outside are the two districts Bao'an and Longgang, they were turned into districts and formally became part of Shenzhen in 1993. Under this rapid urbanization, the urban village issue is rather phenomenal in Shenzhen. The first urban village in China appeared in Shenzhen at the beginning of 1980s. At present, there are 320 urban villages with 350 thousand private dwelling buildings in Shenzhen [112].

In response to the sharp increase in population, the Chinese government has supported self-sufficiency in food production within the district. Urbanization and population growth has put real pressure on the Chinese planning process and has made sustainable urban development more urgent than ever.[55]

[55]In November 11st, 2010, the "3rd International Conference on Next Generation Infrastructure Systems for Eco-cities" was held in Shenzhen and Vice mayor Tang Jie of Shenzhen and Mr. Van Zeeland, Consul General of Consulate General of the Netherlands in Guangzhou suggested the initial idea of promoting G-G cooperation China and Prime Minister Li Keqiang and European Commission President José Manuel Barroso signed "Joint Declaration on The EU-China Partnership on Urbanization" on May 3, 2012 Xu Qin, mayor of Shenzhen, spoke on EU-China Urbanization Partnership High Level Conference 21 August 2012, Shenzhen International low-carbon city launched. Secretary Wang Rong, Mayor Xu Qin Attend launching ceremonyAs animportant part of China's first National Low-carbonDay, thefirst ShenZhen International Low-carbonCityForumwas launchedonJun17th, 2013. Shenzhen International Low-CarbonCityForum is hostedby NDRC, MOHURD, andShenZhen government Dr. Baoxing Qiu, Deputy Minister of MOHURD Mr.RongWang, ShenZhen MunicipalPartyCommittee

Reducing emissions of greenhouse gases in the production of transport and energy is still a critical issue. Shenzhen is now the first mega-region with over 120 million people living in an continuing urban area, going from Hong Kong to Guanzhou. The model of Shenzhen might be a paradigmatic example since it is the largest urban region in order to preserve the agricultural production within its borders.[56]

In 2006, the Shenzhen government began to compile "The Master Plan of Shenzhen 2010–2020" after the approval of The Ministry of Construction (now The Ministry of Housing and Urban-Rural Development). After 10-years of construction guided by "The Master Plan of Shenzhen 1996–2010", the urban structure of Shenzhen has been generally formed. The land use in the SEZ has been relatively arranged as planned; however, the non-SEZ has confronted a serious problem of extensive land use. Therefore, this plan pays more attention to urban intensification in the non-SEZ and an enhancement of the urban structure proposed in the 1996 master plan. A significant feature of this plan is the highlighting of the three hierarchical levels: municipal level, district level, and cluster level and correspondingly, three levels of the development poles are distinguished [113].

Since 2014, the Chinese government has been deepening national low-carbon province and low-carbon city pilot, and promoting low-carbon industrial park, low-carbon community, low-carbon city (town) and green transportation pilot in order to explore low-carbon development pathways and patterns at different levels and indifferent fields.

Each low-carbon pilot area further strengthened by the peak-target-forced mechanism and management system, established the target-oriented responsibility system to achieve emissions control targets, built the low-carbon industrial system, actively promoted low-carbon green lifestyles and consumption patterns, and reinforced low-carbon development capabilities and support. Of 42 pilot provinces and cities in two batches, 13 established low-carbon development funds, and 36 set up developed carbon reduction target decomposition and assessment mechanisms.

(Footnote 55 continued)

Secretary. More than 1400 guests participated the forum to explore new low-carbon development within the context of new urbanization. Shenzhen signed a number of projects with Eindhoven in the Netherlands, Low Impact Development Center in the United States, Auckland in the New Zealand as well as Beijing Energy Investment Co., LTD, etc. Shenzhen and Amsterdam signed the cooperation letter of intent about Shenzhen international low-carbon city project In November 2013 Participated in the kick-off meeting of promotion activity for APEC low carbon model town held by National Energy Administration in July. Participated in high-end conference of China's low carbon urban development held in Singapore in November 2013.

[56]The city of Hong Kong and Shenzhen are also collaborating in the realization of a large area in a central part of the city for the high-yield agricultural production, called Langrab City, commissioned by the Shenzhen/Hong Kong Biennale of Architecture and Urbanism. The model of the Smart City is definitely the way to ensure a sustainable population growth. But the limitations of common goods such as water and other resources require innovation efforts and greater attention to the relationship between built soil and soil for agricultural use. It's never a good investment for the future to leave the rural poor and socially backward areas in the long term, as they often host important resources.

All the pilot provinces and cities have clearly put forward peak targets or are studying the issue, and the peak year proposed by most pilot provinces and cities 2025 or before. Each pilot area started from their realities and worked out many well-established low-carbon development patterns, including urban carbon emissions accounting and management platform, carbon emissions impact assessment, carbon emissions trading, corporate carbon emissions accounting reporting, low-carbon product certification. In September 2015, Beijing, Hainan, Shenzhen and other 7 pilot provinces and cities demonstrated China's outstanding achievements in low-carbon urban construction and response to climate change on the First Session of the U.S.-China Climate-Smart/Low-Carbon Cities Summit.

In June 2014, the Ministry of Industry and Information Technology (MIIT) and the National Development and Reform Commission (NDRC) reviewed and published the first list of 55 national low-carbon industrial park pilots, and approved implementation program of 39 low-carbon industrial park pilots in 2015. Each pilot witnessed a substantial decline in carbon emissions per unit of industrial added value by promoting renewable energies, accelerating the low-carbon transformation of traditional industries and developing new low-carbon industries. In about 3 years, China plans to create a number of low-carbon enterprises mastering core low-carbon technologies and advanced low-carbon management, and to explore the low-carbon management mode suitable for China's industrial parks to lead the low-carbon development of industrial sector.

By the end of 2014, the 7 carbon emissions trading pilot provinces and cities including Beijing, Shanghai, Tianjin, Chongqing, Guangdong, Shenzhen and Hubei issued local carbon emissions trading management measures, covering more than 1900 emission-control enterprises and units and allocating about 1.2 billion tons of carbon emissions quota. Pilot areas reinforced compliance monitoring and enforcement, with the compliance rate hitting 96 and 98 % in 2014 and 2015 respectively. As of the end of August 2015, the 7 pilot provinces and cities saw accumulated transactions of local quota up to about 40.24 billion tons, with a turnover of about 1.2 billion Yuan, and the accumulated auction quota reached about 16.64 billion tons, with a turnover of about 800 million Yuan.

In February 2015, NDRC issued Guidelines for Low-Carbon Community Pilot Construction, which provided a category-based guidance for the selection standards, construction targets, construction contents and construction standards for newly-built urban communities, existing urban communities and rural communities. It also started the studies on Evaluation Indicator System for Low-Carbon Communities Pilot and the carbon emissions accounting methods for low-carbon communities.

In August 2015, NDRC issued the Notice of NDRC on Accelerating National Low-Carbon City (Town) Pilot, which proposed, within about 3 years, to build a number of national low-carbon model cities (towns) characteristic of integration between industrial development and urban construction, rational space layout, intensive resources utilization, low-carbon and environment-friendly infrastructure, low-carbon and efficient production, and low-carbon and livable life. Shenzhen International Low-Carbon City (Guangdong), ZhuhaiHengqin New District (Guangdong), Qingdao Sino-GermanyEco-Park (Shandong), Zhenjiang Guantang

Low-Carbon New City(Jiangsu), Wuxi Sino-Sweden Low-Carbon Eco-City (Jiangsu), Kunming Chenggong Low-Carbon New District (Yunan), WuhanHuashan New Eco-City (Hubei) and Sanming New Eco-City(Fujian) were selected as the first national low-carbon city (town)pilots.

NDRC together with relevant departments organized National Low Carbon Day and National Energy Conservation Week activities in 2015, held the Third Shenzhen International Forum on Low Carbon City, sub-forum "Global Low-Carbon Transformation and Green Industry Opportunities" of International Forum on Ecological Civilization in Guiyang, the First US-China Climate-Smart/Low-Carbon Cities Summit, Forum on Low-Carbon Energy Cities and other activities, which achieved good publicity effects. The Ministry of Transport (MOT) organized the Bus Travel Week activity, and announced the first batch of 30 green recycling low-carbon demonstration projects in transportation industry. The Ministry of Housing and Urban-Rural Development (MHRUD) organized the Ninth China Car Free Day in Cities event in 2015 to call on people to reduce car travels, attracting the participation of a total of 188 cities and counties. The Ministry of Education implemented energy-saving renovation in 18 colleges and universities, carried out such theme activities as "Water and Electricity Saving Week", and organized college students to undertake social practice and science and technology competitions in energy conservation and emission reduction themed "Energy Conservation, Green Energy". Civil Aviation Administration took industry institutions as a platform and held the first training and seminars on quantified management of airline energy conservation and emission reduction [114].

1. Chinese Urban Informality and the redevelopment of urban villages

Shenzhen has been one of the cities receiving large amount of migrants over the last 30 years due to opportunities in the new industries and since the municipal government was unable to meet the demand for housing for these migrants the informal development in communally owned villages became the solution to this housing problem [115].

'…The urban development in Shenzhen is characterized by a dual-track development between regional-based informal process of the urban villages and city-based state-led development of well planned new urban areas. The original villagers are the landlords of the land and buildings. Most of the inhabitants are Chinese migrants coming from inner China. This group is better known as the floating population because of the lack of social security and access to public services in the city, thus leaving them floating between city and countryside.

The economic success of the Shenzhen SEZ has to do with a number of different factors. Shenzhen's location as a neighbor to Hong Kong makes Shenzhen a relatively easy place to invest. The relation between the two cities is often described as 'front dock, back factory'.

But the connection to Hong Kong is not the only factor for its success. In the 2030 strategic plan for Shenzhen that was launched in 2004, Shenzhen attempts to adopt the polycentric urban development model. The employment of the

polycentric model in Shenzhen means that different parts of the city will specialize in economic clusters. One of these new sub-centers is the Guangming new district that will focus on high-technology with an emphasis on green technology and ecology. The municipal government states that Guangming new town is 'a pilot project for scientific urban development by 21st century standards and post-modern concepts'.

Therefore assuming the key role that the urban villages play in the city—making it is useful to analyze the phases of their development.

"…The subject, urban village redevelopment, has received increasing attentions from official and academics since 1990s (Yang 2005). Recently, most Chinese cities urbanized further, urban village and its following issues are more remarkable and deteriorated than before. Urban villages impact urban development on physical aspect in one hand, such as, impact improvement of city imagination, impact enhancement of urban land use efficiency, impact optimization of urban structure and etc. On the other hand, urban village generate series of potential social problems, such as, safety issues by lots of criminal gangs, dual-polarization issues between the landlords and renters and so on. These issues are hidden troubles for social security and stability.

The development of Shenzhen's urban village can be subdivided into the following four phases. The initial phase was from 1980 to 1985. At the beginning period of establishing the special economic zone, the central government did not have enough capitals and capacities to support and patronize Shenzhen's city construction. In that time, Shenzhen local government had to construct the city depending on foreign investment, so it was nearly impossible to compensate the loss of transformation from collective land to state-owned land. So without any formal administration, the farmers of urban villages built large-scale private dwelling houses as a new form of securing their livelihood.

The second phase was from 1986 to 1991. Local government realized large amount of informal settlements that emerged. Thus, municipality drew a red line to restrict the further development of urban villages in 1986. The area within the red line was called new urban villages which were planned by the government, so the living environment was usually better than in the original urban villages. In terms of negotiation, after new villages were built up, the local government took charge of the original villages. And the land of the original village turned into state-owned land, the local government granted the right to rebuild this area. However, due to the absence of capital and policies, the original villages did not develop in accordance to the government plan but continue to deterioration. That means the red line strategy was a complete failure.

The third phase from 1992 to 1998 was an important stage for urban villages' development in Shenzhen. In 1992, Shenzhen government urbanized all the urban villages within SEZ. Original residents got the city "hukou" who were formally 'declared' as urban citizens from that time onwards. All the collective land was transformed into state-owned land. In 1993, Bao'an and Longgang transformed from a county to district, so the villages in these two districts were formally been

transformed to urban villages. Since then, the spatial pattern of urban villages in Shenzhen has been formed.

The last phase is counted from 1999 to present. After rapid development for a long time, Shenzhen has been one of biggest metropolis in coastal region. The investment from domestic and overseas are countless and continues, however, Shenzhen do not have more construction land for further development. Especially, there is no more vacant land for any new constructions in the inner SEZ.

Under this context, the local government has to adjust the internal urban structure, to be emphasized frequently in the municipal agendas.

After 1993, the two counties in the outer SEZ formally changed their administrative level to districts. From that time, the basic pattern and spatial distribution of urban villages in Shenzhen gradually was shaped. There are three figures which reflect the changes from 1999 to 2004 by two indexes, footprint and building area.

That means this district represents Shenzhen' image and would be functioned as an example for the other districts' development" [116].

Within Shenzhen today many urban villages are enclaves that provide an alternate urban realty to that of the generic city [117] an they use their rural vestiges to co-produce the city being "villages in the city" whith a rural-urban distinction which continues to shape identity and politics in postsocialist China [118].

3.4.2 South Korea and Songdo City

South Korea, Republic of Korea, is an East Asian state, which stretches along the southern half of the Korean Peninsula. It is bordered to the north by North Korea, on the west by the Yellow Sea (and then China), on the south by the Korea Strait and to the east by the Sea of Japan (and then Japan). Its capital, the city of Seoul with more than 20 million inhabitants in the metropolitan area, is one of the most populous cities in the world. The landscape is mountainous predominantly, but with 50 million inhabitants, South Korea is the twentieth most populous country in the world (the third after Bangladesh and Taiwan). South Korea is certainly among the first countries to have developed a grandiose project of Smart City. As early as 2009, in fact, the planning of the city of Songdo by a famous New York studio (Kohn Pedersen Fox) started and, on August 7th 2009, were opened the shipyards for the construction of Songdo International Business District.

Besides being one of the urban projects with higher technological content, Songdo is also now one of the largest private real estate investments in the world. The site www.songo.com shows the grandiose project in all its details. Located 40 miles away from Seoul and built on 6 km^2 of reclaimed land in a strategic point, Songdo City is located just 15 min driving from Incheon International Airport to which it is connected by the fifth longest (12.5 km) bridge in the world realised with a tensile structure. Songdo can thus be considered one of the aerotropolises that are rising in the world in these times. Thanks to the presence of the airport, Songdo is just 3 and a half hour flight from economic powers such as Russia, China

or Japan. For these reasons, Songdo City is a candidate to become one of the largest shopping centres in North-East Asia. When the project is complete, by 2017, Songdo City will house 65000 residents offering them a very high quality of life.

Surrounded by 240 ha of parks and open spaces in the project, Songdo City is meant to represent the utopia of the smart city of the new millennium. On the other hand, Anthony M. Townsend in his book "Smart Cities" (2013) observes that entirely new cities, such as Songdo City, seem to grow according to a paradigm suitable to the growth of large companies such as IBM, CISCO and Software AG, and not after a coherent urban planning. Pervasive Internet connectivity and miniaturization of electronic devices with RFID[57] technologies make it possible to remotely control access to buildings and air conditioning. Roads, electrical systems, water and even the waste is accompanied by electronic sensors also monitoring citizens' movements to induce appropriate action in response to the needs of any individual. The city of Songdo will be the cutting edge of electronic technology for presence detection, traffic sensors, installed on buses. These will communicate to users of shared services through mobile applications the arrival of public transport by improving the quality of the service and optimizing time.

The entire city, fully wired with optical fiber, will allow to connect the people with the city operations center that will pick up every single piece of data transmitted. A remote sensing of presence will be installed in homes, offices, hospitals and shopping centres to enable people to make video calls, if necessary. Sensors will be installed in streets and buildings, for constant monitoring, to properly handle any security issue or adjust the internal temperature of buildings, thus reducing waste of energy.

But, as interestingly reported by "The Guardian" at the end of 2014 in the interesting article "The truth about smart cities: In the end, they will destroy democracy", the disturbing sense of distance that assails the visitor on his arrival in Songdo is perhaps not surprising if indeed the city has been conceived, as suggested by Townsend as "a weapon for fighting trade wars", that is a weapon for commercial battles and the idea was "to entice multinationals to set-up Asian operations at Songdo with lower taxes and less regulation".

3.4.2.1 Smart Economy and Smart People

Songdo, imagined as a large international hub for trade, has a Central Business District, which is one of the most advanced in the world. The towers that house the economic and financial heart of Songdo resides in towers built according to energy saving criteria with remarkable results in terms of energy saving and quality of work. "In Songdo International Business District, nearly all aspects of life are

[57]In telecommunications and electronics, the acronym RFID (Radio-Frequency Identification) is a technology for identification or automatic storage of various entities: objects, animals or people. In this way, special electronic labels, called tags (or transponders), are capable of storing data and may respond to the query at a distance by fixed or portable equipment, reader or interrogator.

digitally networked, from sensors that help to control traffic and public transportation schedules, to Cisco TelePresence-based personal video services linking residents to businesses and service providers, to the centralized control systems that manage city services like waste disposal and energy generation" says Tom Murcott, the executive vice president at Gale International, the group developing Songdo.

The other face of the coin is still another reading from Benedikt [119]. Such reading tells us another story. The work in [119] indeed has analyzed—using the example of Songdo—how smart cities especially when built from scratch select their citizens and use technology to refigure them into people considered valuable to compete in the global knowledge economy. In this way, our attention is called to an exclusionist side to the notion of a smart city: the form of governmentality to be found in this city is highly selective from a social standpoint and holds the potential to profoundly upend societal constellations, while pushing those who are already marginalised by the knowledge economy even further to the rims of society.

3.4.2.2 Smart Environment

Songdo City is being planned to meet high standards of environmental and technological sustainability.

The project provides for an area of open spaces that covers 40 % of the total destined to house construction. A 40 park will be built in the center of the city. The urban microclimate is also made comfortable thanks to the public areas and meeting designed to have always available natural light during the day and an unobstructed view of skyscrapers. Particular attention is given to the planting of native plant species. Another important piece of the project's is the water management. In the channel implemented within the Central park flows brackish water, to limit the use of fresh and clean water.

The rain water harvesting, allowed by careful design of the layout of the land, will be at the basis of the irrigation system of urban green areas. Even the roofs of the buildings will be predominantly "green", so as to avoid excessive drainage of water along the roads. As for energy, the project involves the construction of a co-generation system that will provide natural gas and hot water to the entire city. A centralized mechanical system allows the collection of wet and dry waste, avoiding the passage of the garbage truck during the night hours. Sustainability in the construction process is another interesting design element. The use of a by-product of the thermal generation of electric power difficult to dispose of as the fly ash, in fact, can be mixed to the cement. In addition to reduced environmental impact, structures built with this particular concrete have a greater resistance to cold and heat than the concrete normally used. About environment and the history of Songdo development, the work in [119] still gives a different point of view. In many literary sources about Songdo, readers learn that the city was built from scratch. More infrequently, the readers learn that its territory had been partly reclaimed from the ocean; and, even more rarely, that it had hosted small fishing villages before. However, this kind of information paints Songdo as a history-less

city [120, 121]. However Benedikt considers the meaning and consequences of this urban development from a historical perspective. Both the coastal wetlands and fauna and the homes and working areas of numerous fishermen had to be eliminated in order to make way for the new city. In view of the displaced fishermen and the amount of sea life destroyed, there can hardly be talk of a construction on a blank slate. Rather, the construction process can be read as a conscious decision of the South Korean government to adapt its territory, and the ways in which it is used, to the globally expanding economic objectives and sources of the 21st century.

3.4.2.3 Smart Living

The quality of life in Songdo is guaranteed by the presence of areas dedicated to cultural, technological and recreational activites. Among these areas, the World-Class Hospital, an International Preparatory School, a museum, an aquarium, a Golf Club and an extraordinary shopping mall can be found. The dislocation of the delivery of services points and urban functions are imagined to enable the population to live well: the 22500 housing units are being built close to places of provision of services and recreational areas.

3.4.2.4 Smart Mobility

In the city of Songdo, moving between a building and the other is made possible thanks to a system of bicycle paths (about 25 km) and pedestrian paths, which opens up in squares. As for the shared transport, a metro linking the Incheon International airport to the centre of Songdo has been built. Several bus lines connect the peripheral areas to the city and the different strategic points of the city to the centre. Each block has a parking area where the 5 % is dedicated to less polluting vehicles and low-emission vehicles. The parking spaces are in subterranean volumes to facilitate moving on foot or bicycle. Charging stations for electric vehicles are being installed in public areas and also inside the private parking areas.

3.4.3 India

India,[58] officially Republic of India, is a State of South Asia that has as capital the city of Nuova Delhi. For geographical extention is the seventh country in the world and the second most populous country. The shores are washed by the Indian Ocean to the south, by the Arabian Sea to the west and the Bay of Bengal to the east. The

[58]Inhabitants 1,175,000,000 (2012); Area 3,287,263 kmq; density 372.5 inhab/kmq.

coastline has an area of 7517 km. It borders Pakistan to the west, China, Nepal and Bhutan to the north-east and Bangladesh and Burma to the east. Other neighboring states, separated by the Indian Ocean are Sri Lanka to south-east and Maldives to south-west. India is crossed in the middle by the Tropic of Cancer (the boundary between the subtropical and tropical areas); but most of the country can be considered, from a climate point of view, purely tropical. As is common in the tropics, the monsoons and other atmospheric phenomena are unstable and even if droughts, floods and cyclones are rare, they have caused the death of millions of people. Some researchers assert that South Asia will be in the future subject to such natural disasters with greater unpredictability, frequency and intensity. Changes in vegetation, together with rising sea levels and consequent flooding of coastal areas, are among the effects attributable to the current and forecasted global warming.

With the increase of the population, even in India the phenomenon of urbanization has become really important. Experts predict that in 2050 the number of Indians who live in cities will be 843 million with an urbanization rate of 55 %. Today, the rate of urbanization is already 32 % with a strong growth in recent years, although not comparable with the Chinese. To cope with this massive phenomenon, even India, like China and other countries, needs to find more efficient ways to manage urban complexity, to reduce expenses, to increase energy efficiency and improve the quality of life. The Indian government has already allocated more than 1 billion dollars in 2015 to develop 100 new Smart cities in India as well as for the sustainable expansion of existing cities. Even in India the private-public partnership model will be the basis of every initiative. The project of the Indian government is extremely ambitious. Investments on wide band communication and large electrical infrastructures are at the basis of the country's development. The government's commitments provide for the supply of electricity in all the houses for at least 8 h a day since 2017, the widespread installation of smart meters,[59] the installation of test sites for projects on smart grids and creating a centre of expertise on the subject. Generators of electric power with rated power of 88000 MW will be installed by 2017, and there will be new investments in electric facilities. Also 30000 MW of electricity from renewable sources will be installed by 2017. However, India has yet to solve the problem of access to sanitation, roads and minimum health services, things that prevent a quality of life that is barely acceptable. The market for construction in India will live an era of unprecedented expansion, and will become by 2020 the world's third largest market with 11.5 million new homes every year. Even the field of intelligent building management will reach the figure of 1891 billion dollars by 2016. The efficient management of buildings will allow a 30 % water savings, a 40 % of energy savings and a reduction of maintenance costs of the buildings between 10 and 30 %.

[59]Smart meters: electronic devices for the accounting of electricity consumption. The reading is carried out with intervals of 1 h or less and is transferred daily to the distributor.

3.4.3.1 Smart City Projects in India

In India, Prime Minister Narendra Modi has promised to build no less than 100 smart city: a competitive answer, in part, to the inclusion of the theme of smart city in the strategic assets of the urban development plan of China.

Currently, he is already starting the construction of 7 new cities along the industrial corridor between Delhi and Mumbai (DMIC), which winds through six states. The project of 90 billion US dollars includes the regions of Uttar Pradesh, Haryana, Rajasthan, Gujarat, Maharashtra and Madhya Pradesh and is developed together with Japan as a manufacturing and trading hub. Very impressive infrastructures and the fact that the corridor ideally connects the economic capital with the political capital make the project very important for India. On the other hand, the financial plan for this work, the Special Investment Region (SIR) Act, which allows the expropriation of lands, is raising protests in the territories involved in the project.

The involved areas mainly have agricultural vocation, and residents are farmers who do not want to be dispossessed of their property, which often flooded during the rainy season and where each year they see the sea to advance a few centimetres on the coast. This involves a natural hazard that is currently undervalued. The risk of many projects on Smart cities, especially in the East where everything happens at high speed, is in fact that these are being realized undermining the deep foundations of life in urban contexts: smart security, social inclusion, progress and sustainable development. The thrust of the market makes the projects on smart city extremely attractive, but at the same time not natural, such as glossy advertisements.

The "eco-friendly" Indian cities will provide their inhabitants electric power 24 h a day, drinking water, efficient shared urban transport systems, pedestrian and bicycle paths, systems for the complete recycling of waste and wastewater, remotely operated smart electricity grids to control the consumption of smart metering systems and services that facilitate the aggregation and cultural activities. The Indian government believes that these infrastructures will double the number of jobs, triple industrial output and quadruple exports over the next decade.

The first of these cities is Dholera and is going to be built in the region of Gujarat, 110 km from Ahmedabad. The project for the city is ready and the first phase of land acquisition is already well on. Currently, this area of the ancient Gulf of Khambhat city has about 50000 inhabitants and is part of the aforementioned project Delhi-Mumbai Industrial Corridor (DMIC). The other new cities that will have similar dimensions to Dholera are: But-Nesar-Bawal in Haryana, Indore-Mhow in Madhya Pradesh region, and Dighi and Nasik-Igatpuri in the region of Maharashtra; all along the Delhi-Mumbai industrial corridor. The cities will be interconnected to major Indian cities with airports, ports, roads and railways that will be also constructed. Subsequently, another 17 new cities will be built in a similar way. The first phase of investment will see the creation of the first 7 cities within the 2018 and the 2019.

Some innovative ideas to these cities relate to the construction of vehicular routes and underground car parks, the design of roads in order to discourage the use

of vehicles by private users, also, public transport will be be located no more than 10 min walk from the homes or workplaces.

In addition, a managerial city (city-CEO) will ensure the efficient use of services by citizens.

Other similar projects are already in the pipeline in India: the industrial corridor of Chen-nai-Bangalore and Hyderabad-Chennai industrial corridor.

In these cases, it will be favored the industrial vocation of industrial sites along the corridor, such as automobile production in Chennai, Bangalore and aerospace to pharmaceuticals to Hyderabad. The Chennai-Bangalore corridor will cover the cities of Ranipet and Hosur. Subsequently, it is planned to extend this corridor to Belgaum and Mangalore to integrate the extraction from underground, food processing industries, and production of cement.

Other industrial corridors in the planning stage are along Chennai-Madurai-Tuticorin-Tirunelveli and between Coimbatore and Salem.

Other projects include the redevelopment of existing urban settlements. The center EBTC European (European Business and Technology Centre) is infact implementing a pilot project to create a smart city in the industrial city of Haldia in West Bengal. The project will be focused on the possibility of reducing the ecological footprint of the urban community.

EBTC is an initiative of the European Union to support companies in India and in Europe on the transfer of technologies for the production of energy by minimizing the environmental impact. In this case, the Danish companies will be the leader in the export of expertise to India.

Gujarat International Finance Tech-City also called GIFT is a city under construction in the state of Gujarat, about 12 km from Ahmedabad International Airport which will occupy an area of 20 m^2. Project objectives are to provide high-quality infrastructure (electricity, water, gas, centralized cooling or district cooling, roads, broadband connectivity) in order to attract financial and technological companies from Mumbai, Bangalore, Gurgaon etc. where the infrastructure is inadequate or very expensive.

This one, like other initiatives listed above, will benefit from a subsidized regime (Special Economic Zones, SEZ) to easily allow investments. Gujarat will have infrastructure for international education, areas for leisure, an integrated and participatory governance structure, accommodation, shopping and business centres and technology parks. The transport infrastructure will be much safer to reduce traffic accidents. All that will be allowed by:

- An intermodal transport system (Mass Rapid Transport System, MRTS; Light Rapid Transport System, LRTS; Bus Rapid Transport, BRT, etc.) and for regional and urban inter displacements (Ahmedabad, Airport, Gandhinagar and the city).
- Use of soft mobility (walk-to-work) as part of urban planning with a ratio of 1:9 between the private and public transport.
- Use of electric-powered urban transport.

Two towers that will house commercial companies, each one with 29 floors, are already under construction, while work on the third residential tower with 33 floors will soon begin. GIFT is then imagined by the designers as a major commercial hub, IT and financial services; the first of its kind in India, but at the same level of other similar initiatives in the world as Shinjuku, Tokyo, Lujiazui, Shanghai, La Defense, Paris, London, Dockyards etc.…

3.4.4 Singapore

Singapore,[60] officially Republic of Singapore, is an island nation in South-East Asia, located on the southern tip of the Malay peninsula which is connected by two major roads, located 152 km north from the equator imaginary line. To the north it is separated from Malaysia by the Straits of Jo-hor, while to the south is separated from Indonesia's Riau from the Straits of Singapore.

The archipelago is part of which consists of one main island and 58 other islands scattered around. The main island is known as the island of Singapore, but it is officially called Pulau Ujong (island at the end of the earth), is 42 km long and 23 km wide on a territory of 646 km^2. Under the elevation profile, the island is mostly flat, with a series of granitic central highlands of limited altitudes (the highest being Bukit Ti-mah, 175 m above sea level).

The vegetation corresponds to the climate type, but it has been largely replaced by crops and continuous urban settlement expansion in Singapore and the original equatorial forest, still within the island, covers about 3 % of the land area. On the northern coast are frequent formations of mangroves. Singapore has an ongoing reclamation project through the land withdrawal from their hills, the sea and neighbouring countries seabed.

As a result, the surface of Singapore grew from 581.5 kmq in 1960 to 712 kmq in 2010. The projects have sometimes involved some of the smaller islands, which have been merged together through land reclamation work, creating larger and more functional islands, as with Jurong Island.

In the past, the urban area was concentrated in the southern part at the mouth of the Singapore River, where the centre of the city is, while the remaining part of the territory was covered by tropical forest. Since the sixties, the government has built several residential areas in outlying areas, which over time have expanded resulting in a single urban area. Singapore has many rivers and lakes. The two main lakes are located on the centre of the island, where one of the largest natural parks in the world lies. The main waterway is the Singapore River, which runs through the city centre and empties into the Indian Ocean. Other waterways flow into the Indian Ocean or in the channel that separates the Republic of Singapore from Malaysia. The population of Singapore is made up 42 % of foreigners, which makes the

[60]Inhabitants 5.399.200 (2013); Area 716 kmq; Density 7540 inhab/kmq.

country the sixth for the highest percentage globally, and foreigners make up 50 % of the workforce in the service sector.

Most foreigners come from China, Malaysia, the Philippines, North America, Middle East, Europe, Australia and India. The country also has the second highest population density in the world after Monaco. According to government statistics, the population of Singapore in 2009 was 4.99 million inhabitants, of which 3.73 million of citizens and permanent residents of Singapore. Various Chinese linguistic groups make up 74.2 % of the resident population, the Malays 13.4 %, Indians 9.2 %, Eurasian and Arab 3.2 %.

The city-state has a tropical climate, hot and humid all year round. The temperature drops almost never below 20 °C even at night, usually rises up to 30 °C or more during the day: the humidity fluctuates between 70 and 95 %. May and June are the hottest months, while November and December are the wettest with the season of monsoon. Between August and October a pall of smoke is formed from the burning of shrubs in neighbouring Indonesia; sometimes the mist density is such as to create a state of alarm for public health.

The architecture of Singapore has developed mainly from the nineteenth century, scarce are the buildings remained from previous periods (especially some of the fourteenth century pavilions with tiled roofs and crowned with eaves). The widespread neoclassical buildings, from the English influence, has joined the construction of Christian churches, Islamic mosques, Hindu and Chinese temples, evidence of the cultural diversity present in Singapore. Since the eighties, the city has seen radical change in the nineteenth-century image. To the urban development have contributed several architects belonging to government agencies (Housing Development Board, Urban Redevelopment Authority, Public Works Development), local professionals and foreign groups.

3.4.4.1 Singapore Smart City

Thanks to strong infrastructures, the city of Singapore is conquering the record for being one of the smartest cities of the world. Before achieving independence, in 1865, the condition of Singapore was comparable to that of cities like Bombay, Cairo and Calcutta. Prime Minister Lee Kuan Yen was very determined to change the reality. Today Singapore with a population of less than 5 million, has a per capita income much higher than that of many European and Asian cities. This process, although imposed by authoritarian governments, has turned Singapore into a smart city from many points of view. The airport is the fifth in size among those in Asia and the harbour is the second after Shanghai. Six thousand multinationals are based in Singapore, with 3600 headquarters which are located in the city centre. From a recent analysis Singapore is considered the first in the world as regards the economic business. It already held the record as being the most clean city and with less crime in Asia, it is now also the most environmentally friendly. The

conclusions of the Asian Green City Index[61] have shown this. The assessment of this type of leadership, is through environmental performance measures and considerations of 22 major Asian cities by comparing eight different parameters: carbon dioxide (CO_2) emissions, energy consumption, environmental friendliness of buildings, urban transport and mobility, water management and treatment, waste management, air quality and environmental governance. Singapore was the first classified, whereas cities with a greater per capita income became incorporated into lower positions with respect to a special classification.

So, it could be said that the environmental focus is not only among the more industrialized countries, but it goes through an environmental awareness and the ability to implement it effectively. Thirty years ago in Singapore were carried 2.7 million trips per day, today there are more than 11 million. Yet Singapore has no levels of congestion that paralyze many cities around the world. What is the secret? Early planning, timely implementation of the projects and massive investment distributed among the different modes of transport.

Since this is a relatively young nation, the class of experts and technocrats of the Singaporean bureaucracy has had the advantage of being able to learn from the oldest and most established traditions. Urban planning has soon become the highlight of every government and transport infrastructure, a crucial development opportunity.

3.4.4.2 Smart Planning and Building

Following the master plan approved in 2008, the city of Singapore has initiated the design of some sustainable neighbourhoods including the Jurong Lake District. On January 22nd 2011, the Singapore government announced its intention to transform the Jurong Lake District. The plan has implied the redesign of the waterfront where are being inserted hotels, parks and playgrounds (this part includes 220 ha of land and 70 ha of water body), the JCube (a new shopping center with approximately 26000 m^2 of commercial space), five floors of commercial space and an Olympic size ice rink.

Today, the structure is completed. An integrated health hub that includes 700 beds, a Ng Teng Fong Hospital and Jurong Community Hospital, is in full operation since 2015. A network of 24 km of park connectors from Bukit Batok to Jurong East MRT Station is implemented as well as two new parks near Jurong East MRT Station and Toh Guan. The Singapore government has plans to build a district (360 ha)—Jurong Lake District—which aims to become the largest shopping and mixed uses district outside the business district. This implementation is part of a wider decentralization strategy launched by Urban Redevelopment

[61]Asian Green City Index, is the study commissioned by Siemens and presented by the EIU (Economist Intelligence Unit), after analyzing the objectives and the results achieved by the cities considered, drawing a scenario that reveals a widespread environmental interest.

Authority of Singapore to balance economic growth, reducing commuting and providing a better quality of life for its residents. According to studies of the master plan, the area that includes Gateway near Jurong East, Jurong MRT Station and the Jurong Lake District will determine the Singapore economic growth over the next 10–15 years.

New jobs will also be created and new areas for trade in the western part of the island are being implemented. URA has designed the area as an upscale neighbourhood, which means that the land and resources should be used more efficiently and should provide a better environment for workers, residents and visitors. Built around Jurong East transport hub, the area is a link with residential developments, shopping areas, parks and recreational structures, for easy access.

The Smarter Cities Challenge is a program launched in 2011 by IBM to provide expertise and technologies for cities seeking to solve urban problems in areas such as transport, employment, skills development, air quality, education and urban planning. In 2012 Singapore and its Jurong Lake District won the challenge due to the special focus on multi-modal transportation and environmental sustainability. The Managing Director of IBM Singapore, Janet Ang, said that the winning cities in 2012 were chosen as those where the leaders had shown a strong commitment to "… implement the changes necessary to make the city and its citizens more intelligent". The Jurong Lake District project is part of the agreement between the giant IBM and the city authorities; in particular, they are financed by the company to make some studies as regards the design of the district, the grant received by the city of Singapore has been spent along the 3 years of the program, sponsored by IBM Corporate Citizenship Program and its International Foundation. The project for the Jurong Lake District is however part of a broader process of cooperation and governance between the government, companies and research groups.

3.4.4.3 Smart Mobility

Expanding on what was a sketch of the road network left the British colonizers, the politicians started the construction of many new arteries. Beginning in the early seventies, Singapore has opened nine major arteries that run through the whole island, including an underground ring road of 12 km opened 2 years ago, an underground and submarine link. The city opened its first railway line, 6 km and 5 stations, in 1987. Today the rail network extends for 150 km with 106 stations connected with four lines of public transport by road and three tram lines. More substantial funding will go to yet expand rail service bringing the network to 280 km by 2020. With these ambitious expansion plans, the current balance in the modal distribution of the trips, about 6 million by private cars, 3 million by bus and 2 million by train, will probably be moved consistently towards public transport. Since 1983 the government has made heavy investments to make sure that the rail network formed the backbone of an efficient multi-modal public transport system. Today nearly one million vehicles, of which 40,000 come from across the border with Malaysia, move along a network of well-paved roads that stretches for

3400 km. Despite the growth in car ownership rate, unlike many of the neighbouring cities such as Jakarta, Bangkok and Kuala Lumpur, and even examples such as London, Paris and Los Angeles, congestion in Singapore is a rare event. In 1981 in the city-state were only 163355 private cars, now they are increased to more than 600000.[62] The average speed of cars during rush hour on arterial roads is 29 km/h, compared to 16 in London, 11 in Tokyo and 5 in Jakarta. The urban transport management has been entrusted to a specialized company. The Land Transport Authority[63] (LTA) which has managed and still manages urban mobility, provides an efficient and convenient mobility service attentive to the centrality of the person. The three LTA objectives are:

1. Offer a land transport network that is integrated, efficient, affordable and sustainable to meet the needs of the nation;
2. Plan, develop and manage Singapore's land transport to support a high quality environment, making optimum use of mobility measures and the protection of the health of travellers;
3. Develop and implement policies to promote the mode of transport that is most appropriate to the needs of commuters. The public transport system in Singapore is efficient and well organized and allows to easily reach any place in the city.

The main actions for mobility in Singapore in last years are reported below.

– *The Metro line*. With a network of 142 stations across the island and more to come, the Mass Rapid Transit, MRT, and Light Rail Transit, LRT, system is one of the most popular modes of transport in Singapore with a ridership of well over 2 million passengers each day. They connect efficiently the East and the West parts of the city as well as the North and the South parts. Projects like the fully opened Circle Line, the upcoming Downtown Line as well as the future Thomson-East Coast Line will expand the public transport system coverage further. The Singapore's Circle Line, a ring metro, and the Changi airport connection lines have been recently completed. In each RT station is possible to buy a ticket for single runs or the ez-link card,[64] that is easily rechargeable at the ticket distributors in all the metro stations.
– *Purchase and use of cars*. It is a considerable expense to buy and drive a car in Singapore because the government, through various measures, checks the number of vehicles travelling in the state, with the aim of keeping the environment as clean as possible and avoid traffic congestion. The heavy import taxes and other charges also for licensing pose, in fact, an obstacle to the desire of the people of Singapore to own a car. In 1990, Singapore has started a method to keep under control the use of the car. If anyone wants to buy a new car, it is required to buya legitimacy certificate auctioned twice a month (Certificate of

[62]Land Transport Authority, 2015.

[63]Is a governmental company responsible for planning, operating, and maintaining Singapore's land transport infrastructure and systems. It was founded in 1995.

[64]Ez-link card, is a prepaid magnet card for public transport payments.

Entitlement, COE), since without it, it is not allowed to circulate; it is also required to pay a road tax to be renewed every 6 months or every year. The COE has a term of 10 years from the registration date and the cost of a new COE varies from month to month, being determined by a special system that takes into account the engine capacity of the car and the share of vehicles scheduled for that type during the month. Once the car has turned 10 years, it is possible to buy a new COE lasting 5 or 10 years.

- *Congestion pricing*[65] *and the Electronic Road Pricing, ERP, system*. A small and densely populated country like Singapore cannot not only rely on the expansion of the road network. The demand for road space had to be kept under control. The best way to do that has been to take a toll system. A few decades before the European cities, in 1975, Singapore instituted a permit system which applied very demanding rates to all cars entering downtown during business days. The congestion pricing system started in 1998 with the mandatory adoption for each car that entered Singapore to equip with a system that allowed the identification through each of the 69 checkpoints that provide access to city. The ERP is an electronic toll system to enter the city and the Reserved Zone, again with the aim to regulate traffic within the city. This system has a different cost depending on the vehicle, the timetable, the area and the type of road. The boundaries of these toll areas are easily identifiable by blue scaffolding, erected over the road itself. A bright sign indicates when the ERP system is active. Large billboards placed before the scaffolding indicate the cost of the toll. Each vehicle circulating in Singapore is equipped, on the front, with an electronic device called In-Vehicle Unit or UTI. When the vehicle enters the restricted zone, a Cash Card, previously inserted in the device, will signal the entry cost and will be charged automatically. The cash card is a kind of credit card rechargeable in many gas stations or Automated Teller Machine, ATM, and it can be purchased in local post offices or banks. The cash cards are now used regularly in Singapore mainly to pay the "toll" within the city, but they are also very used to access car parks and for buying in many stores.
- *Parking coupons*. To park outside or in the HDB car parking lots (Housing and Development Boards) coupons, that can be purchased at post offices, petrol stations and small neighbourhood stationeries, can be used. The coupon allows to specify month, day, hour and minute of arrival and the time at which it is planned to leave the parking lot. The rates are indicated in each car park by signposts. Each coupon is valid at least 30 min. As Singapore has managed to apply such controversial measures such as congestion pricing and other costly measures when similar systems proposed in several other cities have failed to see the light? A strong local government with an equally strong leadership has certainly been an important factor for the success of such measures. LTA, has limited the protests for the introduction of coupons, lowering the car's

[65]Congestion pricing is a system of surcharges for users of a transport network, operated mainly in periods of peak demand to reduce traffic congestion.

registration fees that had reached 20 % of the vehicle price. But also encouraging trains and buses, which are efficient transport systems and represent a valid alternative to the car, has been quite important for the success of these initiatives. The city in recent years has launched a new round of initiatives, including price increases for motorists, more frequent train rides, increase in preferential lanes for buses, in addition to already provided funding for the expansion of the railway network. Transport Minister Raymond Lim has an ambitious goal: to increase the proportion of journeys made by public transport during peak hours in the morning from 59 % in 2008 to 70 % in the next 10 years. To do that he is committed to make convenient and almost as fast as the car the public transportation.[66]

– *Season parking*. With valid season parking subscription, anyone can park at any car park in an HDB car park group at any time, without having to display parking coupons. Season parking is for long-term parking, and is sold on a calendar month basis. Parking lots in popular car parks are allocated according to order of priority. It will be possible through a web platform to control the status of the subscription and look for other car parks within the same HDB car park group to park at, if the preferred one is full.

3.4.4.4 Running Projects and Recent Experimental Tests

Singapore and MIT alliance: development and research

Already in 2007 the partnership between the Massachusetts Institute of Technology (MIT) with the National Research Foundation of Singapore was created. One of the first principles of this agreement is the interdisciplinary nature of the research groups for the development of the theme of smart city. The sectors involved range from biomedical to the planning of urban systems, mobility etc. …

One of the main outputs concern mobility. The Intelligent Transport System, ITS, department of MIT has developed within this alliance SimMoblity. It is a simulation platform of the Future Urban Mobility Research Group at the Singapore-MIT Alliance for Research and Technology (SMART) that aims to serve as the nexus of Future Mobility research evaluations. It integrates different mobility-sensitive behavioural models with scalable simulators to forecast the impact of mobility demands on transportation networks, intelligent transportation services and vehicular emissions. The platform enables the simulation of the effects of a portfolio of technology, policy and investment options in many alternative future scenarios. Specifically, SimMobility encompasses the modelling of millions of agents, from pedestrians to drivers, from phones and traffic lights to GPS, from

[66]SimMobility is the integrated system of the mobility simulation models to assess future scenarios of urban transport.

cars to buses and trains, from second-by-second to year-by-year simulations, across entire countries.

"LIVE Singapore!", a project developed with the Senseable City Lab at MIT, provides people with access to a range of useful real-time information about the city through an open platform for the collection, elaboration and distribution of real-time data reflecting urban life. Giving people visual and tangible access to real-time information about their city enables them to take their decisions more in synchronism with their environment, with what is actually happening around them. The idea is to provide people information that reflect the actual state of systems and dynamics in their city (think of printed transportation time tables, static opening hours, driving to stores to find a product out of stock,…). Multiple networks collect and organize the data to provide such information. It gives the data back to the people who themselves generate it through their actions, allowing them to be more in sync with the city as well as to taking decisions on the basis of information that reflect the actual state of their city.

Singapore and Esri: agreement for the development of a smart city 3D technology for urban planners

The Singapore municipality and ESRI have signed an agreement in 2013 for the development of a 3D technology. Esri CityEngine is a conceptual design and modelling solution which lets you create 3D buildings and cities in seconds. CityEngine improves urban planning, architecture and design. Use its 3D visualisation power to see the relationships between different projects, assess their feasibility and plan their implementation. CityEngine helps you make quality decisions that will benefit your community for decades. The technology allows comparing and analysing building proposals from every angle and seeing how they fit into the city's overall vision for the future in different scenarios.

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Part III
Approaches to the Smart City Concept: Economy, Technology, People

The city, […], is something more than the congeries of individual men and social conveniences – streets, buildings, electric lights, tramways, and telephones etc.; something more, also, than a mere constellation of institutions and administrative devices – courts, hospitals, schools, police and civil functionaries of various sorts. The city is, rather, a state of mind, a body of customs and traditions, and of organized attitudes and sentiments that inhere in these customs and are transmitted with this tradition.

Robert E. Park, Ernest W. Burgess,
Roderick Duncan McKenzie, *The City*,
1984 The University of Chicago Press

Chapter 4
For a "Living (Lab)" Approach to Smart Cities

Luciano De Bonis and Ferdinando Trapani

Abstract Thanks to the diffusion of information and communication technologies, and despite the huge margins of improvement of the operating conditions of the Web, sharing an idea can be today the starting point for the birth of either a start-up or a community of interests, able to achieve a variety of goals without the intervention of any public institution. In relation to such a ferment of successful micro-level initiatives, Territorial Living Labs are here interpreted as place-based ecosystems of co-creation of goods, services as well as new organizational and social models of smart urban life. From this interpretation, the necessity strongly emerges of a coherent and viable reference framework for a Living Lab approach to the Smart City in the field of spatial planning research. Such a framework is characterized by the recognition of a common (not unique) mode of cognition and communication of both environmental and socio-technical spheres, and by the consequent abandonment of the claim of transcendent control of traditional planning, in favour of an action immanent to a kind of pluralistic as well as inclusive contexts—that we can define frameworks in turn—of innovative self-adaptation between Man and its environment.

L. De Bonis (✉)
Department of Biosciences and Territory, DiBT,
University of Molise, Campobasso, Italy
e-mail: luciano.debonis@unimol.it

F. Trapani
Department of Architecture, DARCH,
University of Palermo, Palermo, Italy
e-mail: ferdinando.trapani@unipa.it

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4.1 Co-creativity, Cities, Territories, Institutions: The Roles of Living Labs

Living Labs (LL) have been established for a long time as models of technological advancement urged by social needs and seen from different points of view.[1]

Among the definitions from which the LL draw inspiration those of user driven [1] and social innovation [2] are central, but especially the analogy between Living Labs and the word "ecosystem" [3, 4], which centers the focus not only in the intangible dimension of social innovation, of new productive organization and co-creativity, but also in the spatial dimension of physical, environmental, organic contingencies and/or as a concept design [5].

From the concept of ecosystem to the meanings of smart city [6], the LL approach is included in various projects requiring partnerships of public and private agents open to innovation. Cities are the ideal but not exclusive Living Labs locations, as it is demonstrated by LL experiences in rural areas, with results to be deeply examined. LL could be part of the new European Union investment policies in the cities, considered, in a polycentric vision, as demographically concentrated territorial settlements and delimited areas where innovation is enhanced and contributes to raise the level of growth, development and increase of the quality of life of every region where they operate [7]. LL could interpret those territorial factors that allow determining if innovation is effectively linked to specific places, or if it is mainly generated by the immaterial dynamics of knowledge and global financial strategies [8].

It is known that cities are the engines of innovation and thus of social and economic development of Europe and US but also this innovation is a key of success of several cities for all kind of their workers [9]. This is due not only to the world's population migration from countries to cities, but also to a new settlement trend according to which the places where goods are produced and the places where the entrepreneurial ideas and the social demand develop are no longer independent. Production is changing to face and overcome the crisis, the civil society faces by itself the problem of the survival of welfare and of quality of life, while politic decision makers don't manage to interpret the deep change taking place, and the same political cohesion of European Union is in jeopardy.

On the one hand, industry hasn't been a competitive agent for a long time and does not strongly influence the urban and territorial settlements as in the past. However, even if the industrial districts have gone into depression because of the global crisis, some of them have levels of growth and economic and social development in which multi-scalability and multidimensionality of processes of innovation and response to market trends, emerge because they prove to be able to withstand strong negative market trends. On the other hand, from the point of view of governments and control systems, cities, territories, regions, Member States and

[1]Although the paper is the result of the joint work of the authors, F. Trapani wrote Sect. 4.1 and L. De Bonis Sect. 4.2.

European Union are separated entities and more and more distant from each other. Governments find it difficult to give a reply to the disruptive tendency of positive and negative production phenomena, to substantial independence of entrepreneurial realities from any supporting policies, to production failures which do not create any entrepreneurial selection but, on the contrary, cause desertification of business and employment. Cities and regions where positive or negative processes are taking place, seem to be helpless in front of what is happening both inside (new leaderships and increase of situations of deprivation, degradation, and social marginalization) and outside them (contact/detachment from value constellations of global market). Thus, it's necessary to undertake new practices and above all policies of integrated planning that don't claim to drive the change of the social, economic, cultural and environmental structure and that are driven by planners who well know their operative condition in the interactive dimension of the territory [10].

Living Labs, considered as real ecosystems of agents that interact creatively, seem to be reference models for multi-scale integration of levels of government.

Thanks to the diffusion of information and communication technologies in the largest part of population, despite the huge margins to upgrade the operating conditions of the Web, sharing a business idea or whatever else can be today the starting point for the birth of a start-up or a community of interests which can achieve many goals without the help of any higher level institution.

The crisis has worsened the living conditions of the lower classes first and then gradually of the middle class across Europe starting from the decline in industrial production and the increase in unemployment. Citizens turn away from political participation as well as is growing a consensus for extremist movements against the economic policies of European Union. At the same time come out aggregation phenomena, which are fragmented and dispersed but present so as to generate the leadership of small interest groups and networks created through the social networks. This ferment of structural actions is confined to the virtual dimension of the Web, but it is encouraged by a large number of successful micro-level initiatives taken without the help of institutions and that suggest a sort of revival of politics outside the institutional channels [11].

Many of these self-organized little communities do not have a physical proximity, but are held together by more or less serious problems of survival, or creation of autonomous jobs, and a mutual comfort on the Web: you look for solutions and find someone who listens and after some time you get an idea that satisfies and induces the various stakeholders to take some initiative. These communities arise locally to face and solve local problems, abandoning the idea that only the institutions can intervene being the ones who can do it for competence, responsibility and nominal allocation of resources. Often they don't have any character of social and political claim because they don't address their requests to the institutions but ask for a wider social consensus exploiting the social networks on the Web. The institutions, moved by the severe crisis of the welfare state and not being able to draw on the public debt, decide to intervene considering the presence of self-organized networks and addressing to them to face and solve problems of city's administration and government.

The social space extends from the traditional public spaces (streets, squares, community buildings), to a type of communication that in the short term can be defined as a whole of ideas, visions, debates that brings to the solution of a critic situation or to an opportunity to be seized by forces in a given urban context. When the situation changes, the thrust is given by human and economic resources already available. Only later the institutions give their contribution and make it possible the support of private capitals. However, these are changing urban realities very different from the great urban transformations based on large investments for major projects led by local and global trusts. The latter in few years create new urban landscapes made of skyscrapers and high-tech constructions, while the result in terms of urban spaces of the Living Labs can be appreciated as intangible, almost non-existent. Great events such as Olympic Games, Expos, etc., have nothing to do with the Living Labs, which are instead demonstrating to act on the social fabric despite their fragmentation, random location in cities and regions, distance from unitary institutional programmes (plans), and apparent lack of resources (economic planning).

We are not yet able to interpret and predict the potential of urban and regional transformation, if Living Labs were to be supported by institutional planning and programming. However, it's important to think about the possible relationship between these two heterogeneous entities: on the one hand, the prediction and programming of institutional actions, on the other the spontaneous and always unpredictable action of ecosystems where Living Labs' co-creativity is generated.

The Urban Agenda is now an important opportunity to reflect on the role of cities and regions where they extend their influence and from which they draw their vital energy. Cities live and develop despite the growing detachment of European citizens from politics, to which voters entrust less and less their hopes for a better future.

The crisis has generated forms of spontaneous and organizational resilience resting on the ability of amplification of the networks, overcoming the barriers of urban and economic marginality. The resistance of some groups to the economic decline creates informal social organization that sooner or later comes into contact with the institutions for various reasons. One of these is the request of recognition of own action without betraying the autonomous character of the transformation of urban areas that have lost their original equilibrium: guerrilla-gardening, squatters, occupation of theatres and abandoned places to produce a self-managed culture, micro health centres in urban suburbs, cultural activities by schools and parishes, debating groups on social, cultural and environmental issues, autonomous forms of support to fight against poverty, assistance to working women, afterschool organized by groups of parents, acceptance and social inclusion for immigrants, social canteens maintained by religious communities extended to lay volunteers, etc.

The free forces fighting against the urban decline ask the institutions the simple recognition of their existence and a kind of social agreement to keep on existing. In south Italy, but not only, there is a growing need to rationalize the use of the assets confiscated from organized crime. This is a clear example that shows how it is necessary the confrontation between institutions and self-organizations in a situation of possible disappearance of public financial capital. The social capital has no longer mobilized to ask for public financial resources but to get exceptions to

current regulations regarding the use of public and/or private areas underused or abandoned. In return, the new urban social forces want to be recognized as worthy to exist and play a public role, claiming their own autonomy. However, the risk is to create new enclaves and barriers. The institutions cannot though look only at the large private capitals ready to buy at a very low price what has been made with the highest cost of human and economic public resources.

Other forms of self-organization and social groups in big cities are those of antagonist type, arising from the common need to solve social problems at different scales and guided by people without defined political representation (e.g., occupation of public or private spaces, abandoned within the urban area). Often in these informal environments spread across Europe there are good conditions for the co-creative working. These environments are completely different from the experiences of MIT, the original context where the LL concept arose and developed.

From episodes of urban antagonism [12] and their prediction of the "revolutionary potentials" of the cities, as Lefebvre asserted, it is possible to see the directions of social innovation, not driven, this time, by the need of a generic improvement of life quality, but by the desperation of the new underclasses, who have to survive in a life now perceived as precarious and meaningless. Living Labs and antagonist forces should collaborate to create a new town arisen from a revolutionary employ of all urban resources (human and infrastructural), without the use of venture capitals responsible for the global crisis in 2008–2009, starting from the mortgages on the first houses. The antagonist forces mentioned by Harvey can be assimilated to the Living Labs seen, this time, as districts where the social and cultural component exceeds in importance the economic aspect, which depends directly on the social issues and not the opposite. Technology makes it possible the unification and organization of social entities physically distant, but united in achieving similar or complementary goals. These dynamics are also applied to industrial production of medium and micro level. According to this point of view, it is difficult to consider the Living Labs as organizational models of innovative production of large-scale industries (industrial hubs). It is instead possible to exploit them for activities of high-level design supporting the industrial production achievable in places and spaces with no environmental impact for cities and natural areas. This demonstrates the implicit connection between Living Labs and cities: environmental sustainability is an essential component for the evaluation of the cultural identity of citizens and livability of residential areas. If industry has fled from western "industrial" cities, now it can get back in a completely different way: miniaturized, individual, simple, highly creative, thanks to the fab-lab that use three-dimensional plots and self-construction of machine parts (or entire machines). No longer traditional banks, but crowdfunding as a financing tool that to some extent can be defined as "fair" because of its transparency and its mutual benefit (win win approach), conceived by stakeholders in search of innovation for new markets produced by the demand of a collective, anti-consumerist and solidary urban life style.

According to Harvey, the city has deeply changed since the global financial crisis and the growing social protest, which hasn't been truly revolutionary

compared to the solid character of the established power. Another change is given by the success of information and communication technologies: they were sold as consumerist gadgets, useless but necessary devices for uncultivated masses with no true sense of life. Nevertheless, these technologies may become an unexpected resistance to wild consumerism and promote those relationships necessary to the creation of a new class consciousness on the part of underused workers or non-workers, who fear social exclusion for not being able to build a legacy of social guarantees and certainties. These simple, miniaturized and more and more "open" technologies (e.g., the fortunate Arduino's case), develop in the cities but spread also in those abandoned infrastructures that, provided with technologies, are recycled giving new value to neglected or underused areas.

Creativity is generated by the urban environments where citizens live their "active life", despite the few means available and counting on relational and supporting networks. So the new town appears as a body made of small, fragmented, scattered, but very strong elements. The quality of environments producing the co-creativity is important to cities, because the innovation required by companies facing the new challenges of markets of the global crisis cannot depend only on the networks with their exchange of information. If the web were turned off or were so expensive as to exclude the lower classes, not only the web communities would stop, but also the entire advanced world. There is an interdependence that hasn't been deeply studied yet. Web space and city space are linked by a new dialectic that explores positive (equity and sustainability) and negative (totalitarianism and poverty) potentialities. The relational potentialities of places of residence, work, leisure and mobility have been revised in consideration of their propulsive function on the social capital. Living Labs seem to recognize this inside transformation of the traditional functions of the modern city. Being deeply linked to urban culture and to innovation research for production, they are a reply to the changed condition of post-modern and post-industrial city. The traditional separation of classes according to the different production units has enormously changed: experts in information and communication technologies collaborate with manufacturing industry and at the same time represent the connection with the social demand; other antagonist groups generate pressure to institutions, asking questions not receiving a reply. The city is changing in some of its constitutive parts, but we cannot say the same for its government. So, how is it possible to realign governments to the social changes occurring in the western city? Since in Europe politics is losing ground, and few become richer and richer while many become poorer, the danger is the definitive separation between dominating and subordinate classes, caused by the process of self-organization and resilience, to which Living Labs in some way belong. Governments are using systems of flexibility to try to avoid the social fight, but the risk is to weaken social rights and guarantees conquered in revolutionary times. Social innovation generated by global crisis causes tension between citizens and rulers now detached from real economy, and this makes any effort useless in terms of sustainable economies and resilience phenomena. The technologic development always remains the aim of hegemonic powers, but the experimentation in social self-organization cannot be stopped and will replace the centralized welfare. Living Labs are today a social

model of work organization that can handle production and distribution processes of goods and services, and where each level is open to multiple communicative directions. Despite the possible separation between global finance and real economy, and thus between city-territory or space-time relationships and a financial engineering founded on risk and capital flows without a central (democratic) control, it is still possible for Living Labs or something more socially advanced to represent a form of democratic resilience to the relentless decline of the western model of development. Living Labs, as an alternative to the Smart City model of multinational corporations and global finance, can contribute to connect the diverging and dichotomic parties of the post-industrial world. Living Labs should now respond to much more complex functions than those for which they were created, since they should act in a changed global context. There is a danger of a gradual, slow, and invisible separation between a social base that has nothing to ask to rulers, finding in itself the energies to go on, and a minority of nameless individuals without social roles and responsibilities, who have the total control of the planet's resources and are legitimated by the laws of market to buy each component of real economies, having the option to erase them a moment later.

The social guarantees and universal human rights will be though bulwarks for private agencies using industrial products, whose investments are more dangerous than those of government organizations [13]. Living Labs can contribute significantly to reduce this process of detachment between the executive parties (vertical) and the creative ones (horizontal), allowing a trans-scalar representation of city and its social groups with their roles and responsibilities.

A tendency emerges in which people don't ask for help to the decision makers as in the past.

Movements or simply cases of active citizenship, which use more or less the information and communication technologies, no longer ask to get something because, for most of the problems arising locally, it is known that decision-making levels cannot solve any problem, not only for lack or shortage of adequate economic resources, but because of inefficiency and ineffectiveness of public domain with respect to powerful private agents, who are not directly responsible for the distribution of public services.

Requests from the social base to the central government have changed because those who express a need, find satisfactory responses through autonomous forms of local organization, result of volunteering and free and spontaneous social cooperation. What is now needed is a recognition of this informal role often in contrast with formal obligations defined by inadequate laws, which are distant from more and more frequent social changes.

In Living Labs production of goods and services involves a multi-actor, multi-scale and highly integrated action. In this case, compared to a social self-organization, the action aims at a scaling up of initiatives of local networks in order to come into touch with networks close to values chains. In the Living Labs social capital values are combined with relational capital values, the latter both horizontal (to maximize the complementarity of districts) and vertical (to be in contact with global markets).

The need of solving urgent problems autonomously, exploiting the few resources available (included those resulting from the synergies of social networks) gives new meanings to the possible convergence of the directions followed by two related systems: the spontaneous ones of local networks of active citizenship and the formal ones of the institutions. After the failure of competitiveness goals [14] and the affirmation of the principle of territorial cohesion [15], Europe has to face two emergencies: on the one hand guarantee the soundness of the domestic financial system and on the other assure the local and informal creative forces that is able to strengthen the connection between university research and entrepreneurial subjects, in the attempt of finding new markets opportunities for new emerging social needs. This will be possible only with new governances, where rights and social guarantees are regulated with respect to the strong power of the holders of the technologies. New connections between ecosystems of local co-creativity and global markets are to be attempted, tested, and capitalized.

Living Labs can perform an important function in solving complex spatial problems, and therefore in the definition of the European Urban Agenda, if they play the role, of a network of creativity, linked to social problems, i.e., of an autonomous response to the emerging issue of local sustainability rooted in the needs of labour markets.

4.2 Some (Further) Steps Towards a Research Framework for a Living Lab Approach to the Smart City

From the interpretation as (potential) Living Labs (LLs), or Urban/Territorial Living Labs (U/TLLs), of the trends and experiences illustrated above (Sect. 4.1), in a way or another considered "smart", the necessity strongly emerges of a coherent reference framework for a Living Lab approach to the Smart City (SC) in the field of spatial planning research.

We already tried to outline some relevant elements of such a framework [16–18] that we will attempt to develop and improve here.

To do this, we will not anyway define the concept of smart city in advance, nor will provide, as it might appear to some extent inescapable, a reasoned list of the so far proposed definitions.

We will refrain from such operations with the express purpose of not separating the definition of smart city from the configuration of a reference framework for smart forms of research in our field (spatial planning), based on an approach to SC, that of the U/TLLs, considered under certain conditions in turn smart.

We will try in so doing to avoid that typically finalistic manner of proceeding that is constantly looking for fruitful results to be achieved in this or that field, regardless of what we could call the ecology of its own garden.

At the same time, we are confident in this way to bring out, instead of pre-define, the idea of smart city underlying the form of smart planning here proposed.

That being said we can easily also say, to begin with, that both SCs and U/TLLs have undoubtedly to do with issues of innovation.

As stated above (Sect. 4.1) the urban/territorial declension of LLs—that considers cities as "real-life experimental laboratories for reconceiving city making and the concept of digital innovation itself" [19]—can be based upon the analogy between LLs and ecosystems. An analogy in turn comparable to the metaphor of Digital Business Ecosystems (DBEs), that is referred to the balancing effect of a higher level of integration between socio-cultural context and economic activities on the long-term economic vitality of a region [20], but deliberately excludes environmental issues. I.e., precisely those issues that we think should be instead treated together with technological ones (especially digital), territorial and social to build a viable reference framework for a spatial planning research approach to the SCs through an U/TLL concept.

To better say, it is necessary to that end to extend the metaphor of ecosystem to all the above issues, basing on the recognition of a common (not unique) cognitive and communicative mode of the environmental and socio-technical spheres, gained under the not dominant but fruitful tradition of studies dating back to the so-called "second-order cybernetics" and to the complexity theory [21–23]. In such a complex (and metaphorical) ecosystem, that integrates ecological, territorial and techno-digital spheres [17]: (i) knowledge is not passively received through the senses or other means of communication, but is actively constructed by the knower [24]; (ii) the function of knowledge is adaptive (in respect to the environment) and it is aimed at organizing the experiential flow by the knower/perceiver, not at discovering any objective ontological reality [25, 26]; (iii) the (autopoietic) system can be described simply in terms of self-productive machine, able to self-reproduce recursively, creating, modifying or destroying itself in response to inputs and to external perturbations [27]; (iv) no designer can establish what should or should not be possible in systems with such great intensity of knowledge, able to build complexity from a set of elementary components [28].

All this is pretty close to the image of the "self-guiding society" [29], but what is worth to draw now from the metaphor, in respect to the innovation issues, is that such ecosystems are always in need of creative and adaptive transformations as they are constantly evolving in response to the changes of their environment. Innovation can be therefore interpreted not dualistically as the opposite of conservation but monistically as its complementary feature.

If and where changes occur—and in such systems some change, somewhere, always occurs [30–32]—there must be innovation (to adapt to changes).

Furthermore, it is only the innovation that generates the possibilities of stabilization and the consequent opportunities of conservation. In the sense that what is worth preserving can only be the result of the processes of innovative self-adaptation of the systems to the inevitable and continuous changes of its environment [32].

We can therefore say that innovation is inherent to ecosystems, and in particular to our eco-socio-technical system.

But, as it is literally impossible to self-adapt to the environmental changes (to which the system is immanent) if not in relation to some "self", we have also to say

that the creative transformation (innovation) should always be thought as emerging from the interaction internal (immanent) to the same self-individual, infra-individual (part of the self) or inter-individual (the social self and environmental)—rather than from separate (transcendent) instances and higher [18].

In other words, we have to say, together with a few other planning researchers and practitioners [33], that the intrinsic immanence of such an eco-socio-technical system requires [18] a radical reconsideration of the assumptions implicit in most of theories and practices of spatial planning, conversely historically prone to transcendence, like indeed many other social and design sciences [34, 35].

"As planning theorists and practitioners we seem to have had a pervasive commitment to an ontology of being which privileges end-states and outcomes, rather than an ontology of becoming which emphasizes movement, process and emergence" [36]. In other words, we have the ingrained mental habit to always referring to the above "ontology of being", static and transcendent, rather than an "ontology of becoming". Such a habit, however, "…may begin to be dissolved by referring to Deleuze and Guattari's concept of "becoming", in which ideas do not come to order from abstract and/or external notions, but develop as part of practical, creative experimentation played out within and between economic and socio-political institutions" [33].

With specific reference to the first of those she considers the three key principles of the Deleuze-Guattarian thought, namely the principle of the "movement or change, immanence" Hillier [33] also points out that in such a thinking the "becoming" is related "…to the unpredictable, indeterminate, never-accomplished actualization of virtualities". Which means that the change "…incorporates "traces" of its genealogical past, which both constrain and also create potential opportunities for the future" [33]. The role of planning, therefore, "…is to make the virtual intelligible" [33].

Although it would be better to say, we think, that it is rather to make "sensible" the purely intelligible, whose virtualities can hardly become actual if not passing also through bodies and senses [37].

As well as we could easily and finally deduce that the actual, intended as a not predetermined and creative outcome of a virtual, in turn intended as a potential, is implicit and therefore it should be found in the folds of the real, rather than sought in the utopian rejection of this latter [37].

Anyway, immanence is not just about opening to an indeterminable future, though without renouncing to a "better future", but is also about abandoning those "transcendent ideal types" [33], which have always characterized the tension towards the eternal archetypes of good city, good environment and good government, so denouncing "a utopian idealism in planning practice present since its inception (…)" [38].

Pas d'idées justes, juste des idées [39] is therefore the contribution that can offer to the unceasing processes of de/re-territorialization a planning intended as virtual practice [40]. I.e., as an activity—or a complex of activities—capable of tracing back to the innovative virtualities immanent in the specific forms and in the actual territorial practices [41, 42].

The waiver of any transcendental rationality in planning has been recognized [43] in the (uncertain) revival of Lindblom's partisan mutual adjustment (PMA), which occurred with the advent of the theory of agonistic planning [44, 45].

In this respect it is useful to take into account that criticisms moved by the advocates of a "radical" model of democracy to both liberal and deliberative models, considered as similarly consensual, are based on a vision of politics considered on the contrary as inherently conflictual; where consensus exists only as a temporary result of provisional hegemony, of a stabilization of power that always involves some form of exclusion. Which implies the absolute centrality of antagonism in the public sphere [46].

According to Mouffe [44], however, while antagonism is a we/they relationship in which the two sides are enemies who do not share any common ground, agonism is still a we/they relation where the conflicting parties, although acknowledging that there is no rational solution to their conflict, nevertheless recognize the legitimacy of their opponents, no longer considered as enemies but as adversaries (or "legitimate enemies").

It is precisely the antagonism transformed into agonism the task of (radical) democracy. Whose prime role is therefore not to eliminate passions nor to relegate them to the private sphere in order to make rational consensus possible—as in the liberal and deliberative models—but to mobilise those passions towards the promotion of democratic projects [44].

Let us go back now to consider, for comparison with the agonistic theory, the physical nature (at least partly) of the "object" of spatial planning. To recognize the essence intrinsically non-linguistic (iconic) of physical space [47], which is irreducible to the function of a signifier of a (rational) signified, in that rather similar to a communication medium [48] of the relationship patterns, not expressible linguistically, among the different parts of ourselves, between ourselves and others and between ourselves and the environment. An essence, which also implies, we believe, that the physical space is suitable neither for (purely) rational discussions, nor for mobilizing (merely) irrational passions towards some (equally rational) end ("project").

This kind of mobilization, in fact, closely resembles to that subordination of rhetoric to dialectic already identified by McLuhan [48]: a rational strategy—a "design" in the sense of Baudrillard [49]—which uses the power of passions to take the power. With the inevitable consequence of highly compressing an entire sphere (not purely rational) of human attitudes, in a way not substantially dissimilar in the agonistic model from the liberal one, and deliberative.

Specifically that sphere closely related to corporeality of both the Man and the physical space, which makes also this latter a medium of relational communication, capable of integrating different human faculties, rational and irrational, without necessarily subordinating some of them to some others [42, 47].

It is just this integrative capability that makes the physical space a shared context, where no sharing of any linguistic meaning is required a priori, and where any difference (of rational "values") is therefore potentially included.

In other words, what the physical space allows is precisely the sharing of the same means by which we relate, i.e., the space itself, with its embodied relational patterns, rational as much as irrational.

The physical nature of the object of planning, i.e., its nature of place that connects the various stakeholders precisely as each of them "holds a stake" [50], is highlighted also by Mäntysalo et al. [43] as a crucial component of the "trading zone" (TZ) approach, particularly in the declension ("trading with the enemy") of Galison [51]. Whose main contribution consists essentially in placing at the very center of "trading" the frameworks of exchange between the different systems of meaning of which the "enemies" are bearer rather than the systems themselves. Frameworks as such able to promote locally coordinated interactions even between enemies (or at least adversaries), and therefore particularly pertinent also for "local" (or localized) planning practices, interpretable themselves as TZs, i.e., "exchange languages" through which "thin descriptions" of ideas, proposals and opinions can be communicated between different groups.

It is however worth to point out the possibility of re-formulating Galison's approach in much more general terms than those strictly related to the "enemy" [18], when taking into account the contextual conditions, inevitably "intercultural", in which the spatial planning processes take place, by now routinely. I.e., if we take into account the differences, in any case very significant, among the systems of values of people that normally interact in the physical space, as well the practical impossibility of tracing today, in any "glocalized" context, some core values, generally shared [52–54].

Once again, we could say that it is the integrative capability of physical space, so strictly associated with its corporeality, which can make spaces and spatial planning a sort of trading zones. Not only between enmities or conflicts but also among any other difference, being possible to reduce any antagonistic or agonistic relation to special cases of the more general relationship among differences.

This means, synthetically, that physical space and spatial planning should never be conceived as exclusive environments, as in the agonistic model, although not for this inevitably consensual, as in the liberal and deliberative ones.

It can further be noted in this regard that to share the physical space is not even strictly necessary to be stakeholders, i.e., to hold a stake of it, if that space is interpreted as a non-linguistic communication medium. In fact, such a medium is in any case capable, at least potentially, to interconnect different "urban entities", regardless of the stakes held and of linguistic meanings (and "values") attributed by the same entities to the medium [47, 48, 55].

In this sense, however, although it is quite easy to identify physical space and spatial planning with potential TZs, it is evident that their operation as frameworks for localized interactions among differences—or even enmities, more or less legitimate—does not depends on their valence of exchange "languages", or by the lightness/thinness of the descriptions made through these same languages. Rather, it is related to the fact that such frameworks, as communication media (not languages), can provide that meta-communicative level to the interaction [32, 47], already identified by Bateson [30] as one of the fundamental criteria of

environmental processes involving "the living", as well as an indispensable factor for the co-evolutionary communication, intraspecific, interspecific and intercultural.

In this direction, it assumes great importance to us the possibility to assimilate somehow physical space and World Wide Web (WWW). In fact, as multimedia (or multimodal) communication medium, the Web shares with the physical space, at least partly, the nature of an iconic medium (not linguistic, or not so much linguistic, at least potentially). With the same basic unsuitability for both the purely rational discussions and the irrational passions "rationalized".

Nevertheless, according to Moussa [46], many scholars [56–59], identify precisely in the promotion of agonistic politics the main contribution of the Internet to democracy.

Indeed, despite the above reported limits of such agonistic approaches, their aspiration to overcome the consensual model of democracy, based on purely rational discussion [60], allows us to extract some useful elements for a not "logocentric" orientation [37] to spatial planning.

These elements are: (i) the detection of the need for a "common ground", rather than shared meanings/values; (ii) the identification of a possible common ground with the Internet (or better with the Web); (iii) the frequent inapplicability to the online conversations of the rational dialogue criteria; (iv) the assimilation, finally, between non-consensual politics and non-hierarchical features and interactive of the Web.

For us however, differently from the advocates of agonistic pluralism, this not logocentric basis are aimed to interpret the Web, or at least some Web-environments, as a non-exclusive framework, though equally pluralistic and non-consensual, for the smart planning.

In conclusion, the configuration of a reference framework for smart forms of research in the field of spatial planning, based on an U/TLL approach to SC, is, in our opinion, a question of "frameworks" in turn. But also a question of finally acting, as planning researchers and practitioners, from within these frameworks, rather than from exogenous control positions, and illusory.

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Chapter 5
Civic CrowdFunding: Sharing Economy Financial Opportunity to Smart Cities

Angelo Miglietta and Emanuele Parisi

Abstract This research aims at reckoning the advantages and criticalities concerning Civic CrowdFunding practical employment along with an evaluation of its actual implementation worldwide. Throughout a theoretical conceptualization of this phenomenon dynamics, we aim at analyzing roles and opportunities of Crowdfunding as a financial tool that helps to reduce local government budget deficits while also appeasing taxpayer's expectations—in a positive cycle that involves basics of sharing economy for the pursuit of Smart Cities. To do so, this research will illustrate classical managerial and entrepreneurial theories that explain the CrowdFunding phenomenon, along with the opportunities and caveats that it entails, in particular the cultural and financial constraints that Civic CrowdFunding implementation might lead to. Indeed, CrowdFunding offers a wider base of potential equity investors, embracing non-professional individuals to invest in ventures that would not be possible otherwise—creating new financial offers and demands. The enlargement of financial possibilities offered by CrowdFunding partially compensates the augmented risk sensitivity from traditional credit institutions and professional investors with reference to equity capital investments—but it also entails new financial risks that shall be attentively evaluated.

5.1 Introduction

The current intensification and proliferation of Local Governments public debt has been largely under the attention of policymakers globally—particularly in the European Union. Indeed, the combined effect of shrinking public budgets and higher taxation aimed at lowering sovereign debt has not been fully compensated in government's providing of adequate welfare services nor sustainable public

A. Miglietta (✉) · E. Parisi
IULM University on Milan, Milan, Italy
e-mail: angelo.miglietta@iulm.it

E. Parisi
e-mail: emanuelemarioparisi@gmail.com

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spending to stimulate growth [1]. This produced first a general social discontent, however, it also boosted people's sensitivity towards mismanagement of public money—thus increasing civic sensitivity on alternative means of raising funds, managing resources and targeting public expenditures.

This phenomenon has created interesting social innovations in the awareness and approach that taxpayers traditionally have to both saving and investing. Both these dynamics are crucial acknowledgements for the birth of "*sharing economies*": entrepreneurial models particularly favored in cities where a combination of social awareness and technological capacity aids these phenomenon to grow. Not surprisingly, "*Smart Cities*" and "*Sharing Economies*" have a number of common denominators, all relating to the partaking of financial endeavors to achieve collectively beneficial outputs.

CrowdFunding and Civic CrowdFunding represent financial outlays that foster citizen's involvement and sensitivity towards the pursuit efficient governance, sustainable resource management and financial transactions transparency. CrowdFunding is an instrument that can alleviate citizens and institutions growing 'concerns over public spending because it involves taxpayers in the decision process, embracing people's needs, demands and possibilities. Accordingly, a growing number of Local Governments worldwide are progressively shifting from top-down decisions to bottom-up chores. In parallel, CrowdFunding grew to become a recurrent topic in most political and economical discussions.

Researchers and practitioners emphasize CrowdFunding outputs as positive for the community due to several reasons. First, Civic CrowdFunding responds to a twofold must: it provides a long sought financial relief from shrinking Local Governments budgets, whilst also extending to citizens the juridical right to be represented when taxed—or at least be more involved in the decision process. Also, Civic CrowdFunding creates new liaisons amongst local governments' administration and citizens—conciliating public budget constraints with individuals need to be involved in the management process. Finally, a sustainable Local Government Budget represents a crucial aspect of any local macro-economic policy and it is eager to boost the appeal of politicians in the elections arena.

5.2 CrowdFunding: Origins and Development of an Innovative Financial Approach

The Global financial Crisis left governments in advanced economies to save their financial system through deficit-financed recapitalization and other forms of financial sector aid. Governments engaged in further deficit to finance spending in order to boost economic activity resulting in the reduction of investments and fiscal revenues of taxation. The overall result has been a rapid increase in debt-GDP ratios, causing credit spreads on sovereign bonds to rise sharply especially in the European

periphery where specialized investors ask for higher yields—virtually paralyzing most enterprise ventures funding tools from both private or public sides [2].

This budget cuts affected above all the public sector welfare areas, where private financing has limited or no investment opportunity and profitability. In the present day indeed, most public and private ventures are experiencing unparalleled shortage of finance for various reasons. First, the financial system enlarged sensitivity to risk has set higher yields for credit access. Second, Government budget cuts resulted in reduced public resources to support enterprises and increased taxes on productive activities. This combination eventually left a growing number of businesses—especially in their early stages of activity—with unprecedented difficulties in attracting investments for their development. Moreover, Public ventures traditionally gathered higher financial support and subsidization throughout taxes and levies on citizens [3]. In fact, publicly financed ventures relied on Governmental funds notwithstanding their proficiency to survive in the free market—as taxpayers appeared to be justifying these expenditures with the thought that public financing represents a development booster with particular reference to regional and local growth [3].

These crisis have however established new financial sensitivity on both investors and citizens. On one hand, citizens understanding of public resources management shifted in favor of a more transparent, efficient and "*smart*" approach—favoring projects that are sustainable, efficient and create value rather than distribute wealth [4]. On the other hand, individuals started being more attentive towards their own expenses—favoring recycling, reusing and possibly sharing properties whose intrinsic value is not exploited efficiently from single users [5]. This new mindset reflects the rising phenomenon of Sharing Economy and Smart cities. In detail, Sharing economy aims at three goals: (1) creating value from a pivotal use of existing assets; (2) fostering efficiency of assets otherwise unused; (3) fostering social responsivity to public expenditures and welfare [6]. Smart cities are based upon some other variables, such as: (1) smarter economic environment and smarter transactions; (2) smarter logistics; (3) smarter environment; (4) smart individuals; (5) smart governance (ITU 2014). We refer in this case to the terms *Smart* as to any approach that leads to a more efficient usage of resources—from *alertness* to *calculation* or *resourcefulness*.

Smart cities and Sharing Economy have common origins and share common goals. They both originate from a sub-optimal usage of resources and both are endorsed by social networks (either digital or relational) to thrive communities' enhancement. The definition of Civic CrowdFunding is efficient usage or sharing of resources enabled by social networks for a common purpose that taps the crowd for the collection of resources to finance projects, a combination of "*sharing-economy*" and "*smart-city*". CrowdFunding is the collection of money for launching a project through online platforms. Projects originate from any entrepreneurial idea with a dedicated business plan that lands on a CrowdFunding platform as it lacks the financial resources for the development—therefore soliciting the crowds for funds. Governments are mostly optimistic about crowdfunding as it may reignites credit

lines for private enterprises and provides resources for public ventures—in either cases enhancing transparency standards. In fact, as taxpayers demand higher regulatory compliance and sustainability of projects, managers become more transparent and attentive towards their duties, and also politicians today base their propaganda on *better services* rather than *more services*.

CrowdFunding represents a natural response to credit crunch and soothe local governments shrinking budgets in their continuing downward spiral of debts—currently worsened by the decrease in private consumptions due to lower incomes. CrowdFunding allows the crowd to finance potentially profitable projects whilst also getting involved in the decision-making process of these firms—acting as *investors* and *potential consumers* at the same time [7]. Instead of having to ask for capital to virtually every potential investor, the entrepreneur can solicit the crowd provide small amounts of capital with a single online campaign pledge. Investments are rewarded with a gift, in the form of a paid interest similar to a *loan,* but it can be a donation, a pre-purchase of the product at discounted price or a merchandising item. The investment can also entail equity subscription; hence the investor can become a equity shareholder in the venture—with all benefits and risks related to it.

Not all projects will be launched, as they are usually "*all-or-nothing*" campaigns. Hence, only those projects that reach the minimum required pledge will be launched. Investors who funded projects that do not reach the threshold will be entirely refunded, and this has lead the literature to emphasize the versatility of Crowdfunding for its eagerness to screen ventures capability, to leverage resources gathered and pool risks. The very existence of the threshold aims at addressing existing resources only to *reasonably* profitable projects once they are approved, supported and funded by investors, and not before. The funding phase indeed serves a twofold objective. First, it conveys the project into actual production providing it with necessary means. Second, it gives the project a *preliminary scenario* of the market impact investors can be considered as consumers—if they deem a project not appealing as investors—they are eager to deem it not appealing as consumers. These aspects largely limit the risks of failure of the ventures, and explain CrowdFunding success these days.

As of 2016, available data provide exciting data of CrowdFunding transactions, totaling worldwide almost 45 million dollars in 2015. Out of these, reports show that *Donation* and *Rewards-based* CrowdFunding are still the most common. Lending based CrowdFunding is growing slower than the previous year—losing its momentum—but also equity based CrowdFunding is growing at slower rates hence with limited perspectives (MassReport 2015). The aforementioned difference is due to the greater degree of regulations for the markets of *equity* and *loan* CrowdFunding. Local supervisory bodies have started only recently to acknowledge the urge to regulate the matter—even if this required the ease of controls posed after the subprime crisis. Since 2008 indeed, Financial Supervisory Authorities and governments have established severe controls on financial markets in order to avoid the extensive sell of derivatives underneath the subprime mortgages. Retail investors demanded for severe controls and guarantees on financial products—and

Regulators worldwide adopted strict regulations to protect investors. These regulations however undeniably affected the emerging retail equity market and it represents one of the main limits of Civic Crowdfunding.

5.3 Civic CrowdFunding: Origins and Advancements

The rise of sharing economy worldwide led the way to several business models that combined private citizens need to optimize their possessions of goods with their wish to make profits. With the same baseline, Civic Crowdfunding embraces the practices of Crowdfunding but it extends it to the funding of local projects. It is both a *mean* and an *end* of the sharing economy and smart city models, as it helps enterprises to provide citizens with better living standards whilst sharing costs and pooling risks—eventually establishing virtuous cycles of controls, transparency and efficiency of usage. This occurs for several reasons:

First, Civic CrowdFunding platforms strengthen the existence of Smart Cities, as they build surprisingly strong social interactions within communities, and they induce citizens to take active roles in their counties while pursuing also other benefits.

Second, Civic Crowdfunding creates added value due to a pivotal use of existing assets. Taxpayers can redirect their resources in favor of projects chosen and financed by them; they choose how and if their money is spent and they perform the screening of the venture whilst pooling the risks and—if it is equity based—sharing the profits [8].

Third, Civic Crowdfunding fosters efficiency of assets otherwise unused or misused—for the same reasons mentioned above. When the citizens choose—the marginal benefit involves more taxpayers than decisions adopted at the top. That is because when taxpayers pool their resources in favor of a project, it is more likely that the venture satisfies the needs of highest possible number of citizens.

Lastly, Civic Crowdfunding fosters social responsivity to public expenditures and welfare. When taxpayers are asked to make a choice, a greater amount of information on the venture shall be disclosed. The due diligence on every venture is hence compound amongst peers, also eventually involved in the management, governance and follow-up activities.

Smarter economic transactions, smarter governance and smarter environments require interconnected networks that share information and resources for the pursuit of common objectives. Such network of benefits can exist only in a community that is already *smart*—that is a network of individuals connected amongst them through networks either digital or relational, and although the conceptualization of Civic Crowdfunding is rather recent, its use throughout history is not.

In 1885, over 120,000 American citizens helped New York City Government to build the pedestal for the statue of liberty. It was the first proved context where citizens spontaneously agreed giving some of their incomes in favor of an

assignment for the community as a whole. Since then, CrowdFunding has emerged as an influential yet crucial instrument for citizens to achieve mutual goal, with collective resources. Currently, there are worldwide examples of its application, underlining its potential usefulness and encountered restrictions.

In Rotterdam, a new pedestrian walkaway has been built connecting two sides of a busy main road in central Rotterdam, thank to locals contribution of 25 € for each wooden plank. A website purposely developed asked the locals to fund the project; in return, they would gain the right to engrave on one of the planks, a personal message of their choice. In only 3 months, locals funded almost one third of the total cost of the project—while Rotterdam Municipality paid for the rest. In 2012 citizens of Glyncoch collected £28,000 to finish a community center for long under construction for lack of resources. Thanks to a website collection of funds, citizens reached the budgets necessary for the finalization of the project, in return allowing the citizens—backers and not backers—to enjoy the Center. In Mansfield, visitors to the site have shelled out part of the cash to bring free wireless internet to the city center—granting them the wiring of the area. Edinburgh's locals collected funds necessary to convert a disused phone box into a tiny art gallery, preserving a national mark as well as creating new forms of arts.

These projects are examples of the countless powers of citizens to shape their community—substituting the traditional *top down* governmental decision with a *bottom up* decision process, evaluated and financed by the people who are directly or indirectly affected by the project development. However, they have all been financed with citizen's levies—de facto substituting themselves to Local Governments.

Crowdfunding strengthened as social networks developed amongst peers. Campaigns success is incrementally based upon the degree of connectivity of the solicited peers. In order to be successful, the campaign shall reach a high number of citizens—thus a digital connectivity infrastructure is required and this is precisely why smart cities enhance crowdfunding. Moreover, the online wide-range setup of platforms allows communities to overcome market *offline barriers* [9], which represented for long time an obstacle to growth and developments of countless areas and neighborhoods where the digital divide still hinders such approahces. Online Civic Crowdfunding can also reduce market frictions associated with geographic distance—and this enable the broadest participation of individuals. Finally, web-based platforms allow smaller financial transactions: a powerful stimulus for citizens with risks limited to their investment [10].

Likewise, to a "Smart City" financial management extent, Civic CrowdFunding can ease some of the traditional problems faced by venture capitals. As it grants face-to-face interactions for conducting due diligence on the project, it leverages the capacity of analysis amongst a compound number of people limiting the risk of frauds. The same approach can be useful in the follow-up monitoring phase of the venture, when the taxpayers evaluate the progresses of their investment. When taxpayers promote a venture to be executed, they become implicitly integrated in the venture directorial structure also throughout non-formal tools (social networks

updates, videos, tweets). This integrated cooperation allows the use of specific and reckonable benchmarks for evaluating their investment, for instance upon periodic goals given results [11].

5.4 CrowdFunding for Citizen's Ventures and Effect on Local Governments

When Taxpayers acknowledge the non-sustainability of governmental debts in the long term, they feel the urge to ascertain how their money is spent and likewise they expect more accountability of the projects they contributed to launch. It is hence normal that once public budgets shrink, people grow a need to invest more responsibly in their communities also through the possibility to finance personally ventures when the public fails to do so [12]. This highlights a first practical distinction amongst types of Civic CrowdFunding: either it occurs to enhance means or services—either it occurs to provide a service ex-novo. The first situation is when the input is totally bottom-up—such as the building of a children park, or a community center, or a school bus. The second situation concerns ventures financed by citizen's *partial* substitution or in *complement* to the government, as the latter is not able to provide the service alone or the same can be better provided with private contribution. For example, when citizens support the completion of a project by covering part of its costs.

In either cases, CrowdFunding is virtually open to any individual: this represents a crucial aspect of its success. Evidence shows how in the past, most civic projects led by private citizens were restricted to groups of people with a specific interest—whether they shared specific political views or shared common expectations [13]. Today, Civic CrowdFunding embraces the general crowd expectations—virtually anyone—rather than particular groups with common and specific interests.

Researches show that citizens do not mind to co-invest in private or public projects—de facto establishing enhanced forms of cooperation—when these ventures lead to a more sustainable life quality, to moral rewards or to a better allocation of resources [14] that benefit the collectivity. The achievement of a "*Smart City*" is based upon these achievements, and mostly contributes to the success of Civic Crowdfunding. In order for individuals to gather and invest in a project whose benefits may spill to virtually everyone, the target shall be well defined prior to the campaign and shared by citizens. Once the target is aligned the project gathers the adequate legitimation, Civic Crowdfunding may be the financial vehicle to fund it.

Different experiments have been carried out globally in order to generate enhanced forms of cooperation between civil society and Government. Main target of these experiments was to understand the origins of the psychological distance between citizens and Local administration and what factors contribute to the creation of the answer to these problems. In other words, what factors thrives the so-called *self-help* groups of the society to contribute financially to public ventures.

A helpful experiment based upon the involvement of local communities and the financing of projects via governmental levies is the *Participatory Budgeting* activated in the 1980s initially in Porto Alegre and subsequently expanded to over 70 Brazilian cities. Participatory Budgeting is based on the establishment of Governmental Bodies aimed at guaranteeing popular participation in preparing and carrying out the municipal budget. Once citizens have aligned on both goals and means, local government accordingly distribute resources and prioritize investments. By doing so, Local Administrations establish a sustained mechanism of joint management of public resources through shared decisions upon allocation of budgetary funds and government accountability concerning the implementation of decisions. Also, these platforms allow small Financial transactions (e.g., USD$10) to enable the broadest participation with limited downside risk, and they provide investment information (i.e., cumulative amount raised to date and the online identity of current investors) as well as tools for investors to communicate with each other in an effective and easy way. Finally, prioritization of resources and determination of projects is evaluated as a result of an algorithm factoring budgets accountability, citizen‘s mobilization and impact on community as a whole.

The Participative Budget has proved over the years that transparent and democratic organization of resources can avoid corruption and above all misgovernment of public funds. The Participative Budget has also showed effective tools of participation and the commitment of the Government in developing what the population decides, cut the chains and the bureaucratic barriers that separate the society from the State, forming an active and mobilized citizenship. However, it also shows some limitations: the technical feasibility for establishing Participative Budget involves a high degree of civil participation and mobilization that is challenging to reach in the short term. In addition, this approach scarcely allows space for discussions over long-term policy issues and projects because citizens show more attachment to projects that affect them rapidly rather than in the next future, therefore limiting projects that aim at programmatic achievements, it shows. Moreover, it is an excellent tool for—small things‖ but not for substantial development projects such as Real Estate, Transports and Technological city enhancements.

The evaluation of strengths and weaknesses of Participative budget Experiment shows some interesting relations with Civic Crowdfunding to the extent of this research, highlighting risks connected to Civic Crowdfunding and means to prevent them. First, Crowdfunding involves a substantial lower involvement of citizens and institutions compared to Participative budget, as it is completely voluntary. Civic Crowdfunding is a process that does not depend on traditional democratic validation, yet granting de facto a high-shared consensus standards by the spontaneous and undifferentiated funding from citizens. In other words, only citizens socially and economically interested in the project—or interested the potential profits of the project—or simply interested in the social impact of the project—proceed to its financing. There shall not be any negative impact on those citizens that for different reasons have not agreed to finance the project [15]. Also, as past experiences of

Civic Crowdfunding globally demonstrate, Crowdfunding has no boundaries with reference to projects achievable, as it embraces ventures spacing from significant requalification projects to small local assignments, also called Micro-Crowdfunding [16]. Finally, Crowdfunding is a powerful instrument for evaluating the feasibility of a project before a single resource disbursed for it, and this aspect has raised shared consensus in the literature.

This statement finds evidence also in a theoretical perspective. Schumpeter's Supply Push model states that Market innovations originate when new consumer's urges arise. Resulting innovations are materially accomplished only when the consumers' demands cross the supply—hence leading the new production. This process normally needs time to develop. With CrowdFunding, consumers needs can be easily aggregated into a project and submitted to the public for the approval and funding. Consumers need—*demand*—and Producers need—*supply*—draw together precisely when the project meets potential funders.

The classic producer-consumer interaction—where the firm understands consumer needs upon its own sensitivity and creates products intended for them—is reshaped in Crowdfunding in a new specification that sets the demands of customers before the supply of firms. This is particularly interesting especially with reference to Civic Crowdfunding. As recent studies show—several projects presented on platforms originate from consumers who establish their own business as they fail to find the products or services they desire in the market. The revolutionary element of Crowdfunding is that starting a venture is no longer reliant entirely on traditional means of entrepreneurship—personal assets, credit availability or investment possibility—but mostly depends on the capacity of other consumer-investors to participate in the project—creating unexpected development possibilities [7].

5.5 Financial Aspects of Civic CrowdFunding Implementation

As previously anticipated, debts and budget deficits are not the only tools to finance local projects and boost local growth. When citizens are connected, informed and eager to contribute to their community growth, they also play a proactive role in finding resources and addressing their money into the achievement of common goals such as the establishment of Smart Cities. Civic Crowdfunding purposely aims at enhancing community's standards *through* financial cooperation amongst individual whilst fostering the ability to control ventures financial management. Its theoretical potential in supporting the establishment of "*Smart Cities*" is acknowledged in the literature, as it represent a tool that sets the future pattern of *Smart Cities Design* [17]. In other words, citizen's financial appeal in public spending, and their contribution in driving ventures—fosters a critical mass of inputs that boost the success of a Smart City (connectivity amongst peers, pooling

of financial resources, sharing of objectives). As Civic Crowdfunding requires an adequate baseline of city "Smartness" to function, the two phenomenons are interconnected. The more a city is "*smart*"—the more Civic Crowdfunding can perform.

Aside from intrinsic boundaries set by the "*smartness*" of a city—Civic Crowdfunding actual implementation may encounter some barriers that relate to regulatory constraints or cultural reticence. Empirical evidence in fact demonstrate that Civic Crowdfunding bottom-up approach—originating and addressing to citizens—may operate only within a facilitating legal framework. This aspect is peculiar to every venture connected to *Sharing Economy*, as in most cases, the regulations in force prohibit sharing activities especially when these have no similar past records; or may require new regulations to support its development. This situation affected some of the most relevant examples of sharing Economy—UberPop, BlaBlaCar, AirBnB to mention. Civic Crowdfunding, as mentioned in the introduction, encounters its biggest constraint in the equivalent regulations previously adopted to protect investors. That is because after the financial crisis led by the subprime mortgages in the US and its spiraling junk derivatives sold globally—most governments adopted specific regulations aimed at avoiding risky financial services distribution to unaware investors. This enacted regulations such as "MiFid" and "MiFid II" in the European Union and mandated considerate "profiling activities" prior to any financial investment.

However, people support initiatives when these are profitable and the ratio amongst profitability and risk is proportionate. To this extent Civic Crowdfunding can be valuable when is donation-based, as it leverages citizen's demands for a better community in exchange of a donation—with no economic profitability to be measured. If Civic Crowdfunding aims at substituting or adding-up shrinking public budgets as an equity investment—it requires close cooperation amongst governments and Financial Supervisory Authorities. Either because it needs a facilitating legal setting to grow strong—and to avoid that it repeats the same consequences that the strict financial markets regulations aimed to avoid at first place, such as non-compliance with transparency and lack of efficiency standards. In other words, the supervision required for any public management of resources shall apply to privately Crowdfunded ventures. To this extent, Regulators globally are formalizing minimum regulatory settings in order for Crowdfunding to operate correctly, to avoid frauds and limit poor governance of projects funded via solicitation of public capitals.

These regulations, as highlighted in the literature, virtually mirror the regulatory setting already in force for financial investments distributed by commercial banks and investment funds. As some argue that this *regulation obsession* may compromise the potential successfully implementation of Civic CrowdFunding—others claim that technical boundaries shall be traced when dealing with private savings in order to tackle all risks of frauds [18].

Despite these concerns, at the origin of Civic Crowdfunding, at first place the city shall be "smart"—hence, a community that fosters cooperation amongst peers

and institutions for common Goals [17] and highly interconnected. Second, Civic Crowdfunding requires government commitment to enable and provide it with the legitimacy it requires—and a strong civic sensitivity amongst and between government and citizens. Third, any project that regards the community requires grouping citizen's expectations investigating on needs and priorities. Lastly, projects have to be financially stable and sustainable—and meet investors' financial expectations.

Lacks in the abovementioned conditions does not endanger the venture success —and actually, it may be helpful in reshaping the project in order to let it gain more funds and more citizens. It is due to the mentioned role of Crowdfunding to provide a market scenario of the project extremely valuable for its future implementation. Finally, once the project is executed, also non-investors acknowledge the efforts of their community for the project launch and understand the commitment, spreading a new sense of belonging and respect for common resources that can hardly be achieved when public resources expenditures management is hidden or hard to trace.

5.6 Cultural Aspects of Civic CrowdFunding Implementation

Concerning cultural reticence, not every citizen is willing to invest in activities traditionally offered by the state. The financial crisis has enlarged the polarization amongst citizens who support the Welfare State and people who support private welfare [19]. Despite these different political views—not relevant to the extents of this analysis—the literature agrees that Civic Crowdfunding ventures addressed to the public and in general any investment opportunity solicited to the community shall be beneficial to all citizens and virtually hurt no one in the perimeter of reference. In other words, governments shall not allow private participation in public chores when this may harm or provide worse services to some One can argue that there are possibilities to overcome even these obstacles—such as vouchers for example as pictured in Friedman's capitalism and freedom in 1962. However, policymakers shall draw a line amongst services where the private shall operate and where it shall not. To this extent, the literature states that good local governance can exist only when Administrations and Citizens collaborate actively in pursuing political and economic objectives [20], hence emphasizing the importance of *shared targets*.

This aspect is extremely important when it comes to Civic Crowdfunding, because it allows communities to establish *self-help* groups for numerous activities for the community. Its decisional process is not based on democratic validation of the majority but on the funds gathered. This highlights the need for a preliminary alignment between civilians and officials on both means and areas of civic CrowdFunding intervention [21].

Second, in the last year's most local governments have largely relied on debts for their investments on the community. These debts could be issued as governmental bonds, banking loans or loans from national institutions purposely designed for financial aids to local governments (*Cassa Depositi e Prestiti* in italy, *Caisse des dépôts et consignations* in France, *Instituto de Crédito Oficial* in Spain). Accordingly, considerable economic research strongly emphasized the non-sustainability of debts for economic growth. There is a growing shared consensus in the doctrine that debts arising from large public expenditures may often lead to a worse outcome: little new growth to show for their efforts [22]. In contrast, Civic CrowdFunding shows positive aspects in over passing these issues. Civic Crowd-funded projects are no debt-based, as the launch of projects depends on funding voluntarily granted from citizens. Moreover, the collaboration citizens-governance might avoid officials corruption and above all misgovernment of public funds, due to its increased adoption of transparency standards and greater compliance with feasibility assessment for each project financed [23]. Lastly, as the local budgets deficits decrease—in consideration of the decrease of public expenses for local projects—also the yields on debts decline, giving the local governments more resources for performing those activities that cannot be funded by the crowds.

Moreover, if communities adopt civic CrowdFunding processes for a spectrum of activities, Local governments may concentrate on activities that—when performed by the local governments can lead to better performance. This aspect is an important variable of public ventures efficacy, as it is well recognized in the literature that according to the subsidiarity principle and especially in the EU, the body closer to the center of interest is the one operating at its fullest and best [24]. This process grants several advantages in terms of efficient allocation of resources and best fulfilling of expectations. Through civic CrowdFunding, ideas on community development start from the center of interest and therefore are technically at their closest possible connection link with the interest or goal pursued. Of course, not all activities can be attributed to civic Crowdfunding, as the primary governmental functions shall not be transferred without affecting all citizens; we refer in this case at instructions, jurisdictions and defense, along with others.

5.7 Conclusions

This research aimed at facilitating the qualitative descriptions of its potentials and to recall some success cases of its employment within the cumbersome sets of all public-private joint ventures possibilities experienced in these last years. Also, the research aimed at reviewing means and views for eventually producing shifts in the perspective on traditional entrepreneurship and Local Administrations spending techniques. By recognizing and appreciating the complexity and variation of abundant possibilities in the phenomenon of new venture creation, Civic CrowdFunding can be useful although the mentioned criticalities that such instrument encounters when applied to local governments activities are still an obstacle to its

implementation. This for different reasons. First, Civic CrowdFunding is a current progressing phenomenon whose evolution output will take long time to be reckoned. Also, its success depends on the diffusion within communities, and to do so, inventive payments technologies shall be implemented and the notion of Social-Citizenship shall reach new levels of integration within and between all local communities. In addition, Civic Crowdfunding requires a strong and effective management and monitoring at regulatory level—either locally, nationally and internationally.

The abovementioned perspectives highlight means and tools of Civic Crowdfunding for relieving growing pressures on Local Governments budgets. Civic Crowdfunding can be indeed considered an effective tool for citizens to address and monitors resources for civic projects, without having the Local Administration to hunt for ways to cut the budgets deficits.

Critics to this approach claim that civic projects should be funded through taxes and managed by city governments, provided however that this approach has demonstrated unrealistic [25] and that nowadays lesser projects can be financed solely on public funds. Taxpayer money might not be enough to cover all public needs, and besides there is actually a lot of restrictions and limitations on what kinds of project government can fund. There are also complicated processes for authorizing projects and assigning capitals even with private projects financing, whilst Crowdfunding tools provide a way to cut through some of the bureaucracy around funding and access new streams of capitals to add to what government already provides.

With the evolution of its use, and before the matter is entirely disciplined, the bottom up processes shaping Civic Crowdfunding shall be attentively monitored in order to track its advancements—but the interest placed on both Smart Cities and Sharing economy by policymakers and individuals—seem to set the path for an intense growth of this instrument.

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Chapter 6
Smart Community Infrastructures

Eleonora Riva Sanseverino and Valentina Vaccaro

Abstract This chapter outlines the concept of intelligent and multi-service infrastructures, addressing the interesting aspects of multi operability, potential of cogeneration and multi-carrier energy hubs, whose basic concepts were only recently described in [1]. The infrastructures that serve a community, such as energy distribution, water and waste piping, mobility and ICT networks are, in fact, the most important means for efficient operation of cities. The chapter, after outlining the contents of the document ISO TR 37150: 2014 concerning the *Smart Community Infrastructures*, highlights the different approaches needed to implement them within existing cities and newly built cities. At the end, the chapter presents the concept of Energy Hub and some cases study of urban districts (existing district and new built district) modelled as Energy Hubs.

6.1 Introduction

The uncontrolled growth of urban areas (more than 66 % of the world population will live in cities by 2050), which will lead us to face huge environmental and social problems associated with the residential sector [2] and with the consequent development of infrastructures networks, is a critical element of urban planning of our times, in that it may threaten the sustainability of existing urban areas. This is the reason for which the demand of *Smart Community Infrastructures* is increasing, namely of intelligent and multi-service infrastructures. The demand for such intelligent infrastructures, offering integrated services in the urban context at different scales, will grow in the coming decades. For this reason, the International Organization for Standardization in February 2012, has established a technical

E. Riva Sanseverino (✉) · V. Vaccaro
Dipartimento di Energia, Ingegneria dell'informazione e Modelli maematici (DEIM),
University of Palermo, Palermo, Italy
e-mail: eleonora.rivasanseverino@unipa.it

V. Vaccaro
e-mail: valentina.vaccaro.pa@gmail.com

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Table 6.1 Layers model of a Smart Community in ISO/TR 37150:2014

Layers	Examples of functions
Community services	Education, healthcare, public safety and security, tourism, etc.
Community facilities	Residences, commercial buildings, office buildings, factories, hospitals, schools, recreation facilities, etc.
Community infrastructures	Energy, water, transportation, waste, ICT, etc.

Table processing by [3]

Table 6.2 Community infrastructures

1	Energy	Electrical networks, Gas, Fuel (distributors),…
2	Water	Water treatment units (for industrial and non industrial use), systems and networks for depuration, systems and networks for water reuse, …
3	Mobility	Roads network, railways, airports, ports, …
4	Waste	Collecting and valorization of waste, recycling, …
5	ICT	Collection and use of data, distributed sensors networks, monitoring systems, Wifi, …

Table processing by [3]

committee, ISO TC 268- Sustainable Cities and Communities [2], for the definition of standards and benchmarks for measuring the performance of the Smart Communities and for their efficient management, also in terms of infrastructures. With regard to infrastructures, the reports published to date are three: ISO TR 37150: 2014, ISO TS 37151: 2015 and ISO TR 37152: 2016, aimed at providing definitions and parameters related to the so-called hard smart infrastructures. The mentioned ISO norms introduce the concept of Smart Communities schematized through a hierarchical structure arranged in layers where hard infrastructures constitute the basis (Table 6.1). The norm ISO TR 37150 - "Smart community infrastructures - Review of existing activities relevant to metrics", [3, 4] was the first to be developed. The latter, wit reference to the above cited structure, else than identifying the physical infrastructures, or as they are called the *Smart Community Infrastructures* (Table 6.2), nalso ondicates theor expected performance with reference to the main stakeholders (Table 6.3).

The idea that is realized within the technical documents is that behind the services offered to citizens of every community there are the infrastructures: for supplying energy carriers (electricity, gas) and water, sewage pipes, waste management, roads, public transport, phone lines, internet access, etc. In the upper layer, are located the most important aspect to be addressed: the services layer. This level must be optimized to be sustainable while improving the quality of life of citizens (for example reducing costs, increasing mobility and accessibility and reducing environmental pollutants). Infrastructures are precisely the layer on which to act to optimize services.

Table 6.3 Relevant aspects of performance from different points of view

1	Citizenship point of view	Reliability, availability, service quality, safety, …
2	Administrators and service managers point of view	Operational efficiency, resilience, expandibility, safety, …
3	Environmental point of view	Resilience to climate change, respect for biodiversity, natural resources conservation, pollution monitoring, water scarcity management, …

Table processing by [3]

From Table 6.3, it can be observed how the discussion about smartness of "Community Infrastructures" must consider an equilibrium among different points of view in line with the holistic concept of smart cities. The report, which is designed as a general introduction to the concept of intelligent infrastructures, presents the concept of smartness of Infrastructures in terms of overall performance and technologically feasibility as well as integration of solutions. Specific standards for each infrastructure (power, water, etc.) are therefore not treated, instead the entire urban infrastructure system is understood as "system of systems". The report provides information on some existing and advanced technologies, in order to provide a tool to identify appropriate design solutions that are assessed with regard to the environmental aspect, the economic efficiency and improvement of the quality of life of citizens. But what requisites and performances must have such a system to be classified as a *Smart Community Infrastructure*?

The definition agreed upon by ISO is the following:

- High efficiency;
- Low environmental impact;
- Allowing integration and cooperation of more infrastructure;
- Long-term adaptation capacity to external (urban/climate) and internal changes of the infrastructure itself.

ISO is still working to define ad hoc documents for classes of communities. This approach is quite similar to the one proposed in Chap. 1 (Sect. 1.3) and concerns the necessity to identify "benchmark" cities to which administrators can refer.

Indeed, notwithstanding the fact that every community would want "multi-service and intelligent" infrastructures (in terms of high environmental performance, usability and management infrastructure is concerned), it is undoubtful that, such as the climate and urban features, also the infrastructural ones are strongly characterized by the context in which they are implemented. There will thus be different infrastructures in "industry oriented communities", or in "smart small islands[1]", or in "academic oriented smart communities" [2]. It was already mentioned that the district scale, at an operational level, is probably the best one to

[1]For a deeper analysis of the issue please see [5] and [6].

get energy efficiency objectives and welfare of citizens. It probably is also the best scale of reference to test new design solutions. It is for this reason that, in the following sections, the problem of identification of the infrastructure layers for districts for existing cities and newly built cities is addressed.

The last paragraph develops the concept of Energy Hub. The reported case studies, which refer to urban districts, materialize the interoperable infrastructure model discussed in the chapter.

6.2 Pre-existing Cities: The Integrated Planning Through Infrastructural Layers

When cities host a valuable historical center, it seems appropriate to operate on distinct aspects:

- Energy efficiency upgrading of buildings, where possible;
- ICT infrastructure strengthening (free wi-fi access);
- ICT infrastructure installation for monitoring and service networks management;
- Actions for mobility.

The improvement of energy efficiency in buildings must start with the analysis of the building stock based on construction times. This will make it possible to identify the building types, the criteria for the identification of the neighborhoods and possibly the identification of the connection points to the main public services networks (water, electricity, gas, waste, heat, etc.). Once identified building typologies, it will be possible to identify an adequate set of measures for energy efficiency improvement and standardized procedures for their implementation.

The second measure is already being implemented in many Italian and world-wide cities, and is not particularly critical beyond the aspects of massive pollution of the environment from the electromagnetic point of view, whose effects have still to be clinically evaluated.

As regards the third aspect, currently, in many countries still there are not multi-service ICT infrastructures, namely able to accommodate data that refer to more services provided to each of the users.

In Italy, this is an effect of a regulatory mechanism that:

- does not allow the access to the gas remote metering network by other operators;
- has failed to set the manager's figure of the ICT multi-service infrastructure.

The use of a single ICT infrastructure for managing multiple services would translate into a saving for individual managers who would share the costs associated with connectivity and a less invasive infrastructuring. More distinct communications, in fact, provide for a greater electromagnetic pollution and the installation of a

greater number of under-utilized devices for the repetition of signals, their conditioning and eventual conversion.[2]

On the other hand, if the notion of multi-service infrastructure can lend itself well to monitoring, it is not yet clear to what extent technically similar solutions could be applied to the management environment. The time constants of the physical phenomena involved in the management of electrical services, water distribution, heat distribution, etc. are highly differentiated and so they are the response times and the dynamics associated with management.

Nevertheless, there are several experiments of infrastructures dedicated to the management of multiple services concurrently in the world to achieve a goal of reducing energy consumption.

To demonstrate the interest in Italy for a multiservice management logic, in September 2014, the AEEG (Authority for Electricity gas and water system) has announced that in nine large Italian cities will begin testing in the field for gas, water, electricity, district heating and other public utility services of "smart multiservice meters", for a total of about 60 thousand supply points involved.

The pilot projects of remote multiservice management will be implemented in Turin, Reggio Emilia, Parma, Modena, Genoa, Verona, Bari, Salerno, Catania and in some smaller municipalities as determined by a special commission composed also by external experts appointed by the AEEG. Funding for the projects comes from a small contribution by consumers (about 10 cents a year for nationwide consumer), taken through the gas bill.

The idea is that of a shared infrastructure to transfer the consumption data from electricity, gas, water counters to the different suppliers. An innovative and technically advanced solution that would reduce the costs of ownership and operation of services, ensuring optimal management of data flows. The results of the experiment will be published and made available to all operators of services directly regulated by the Authority, but will also be made available in other sectors such as street lighting or other services for the "smart city".

Among these, the testing of sensors for dedicated parking for the handicapped (ASEC company in the city of Catania); sensors for noise detection (AGSM company in Verona); sensors to measure the filling of waste bins (Hera company in Modena), sensors for detecting public water leaks (Pulia Aqueduct and Municipality of Bari). The Authority has also provided supplies to customers on their energy consumption information "online" and in a multi-service vision. Although the counters of different users will remain separate, customers can access a single website where they find all consumption for the various supplies.

The implementation and management of remote multi-service systems can be organized by "third parties". The required times for implementation are of 1 year and of one or 2 years for the operating phase; in this last phase, the subjects that perform the experiments should send regular reports to the Authority and

[2]http://www.telecomitalia.com/content/dam/telecomitalia/it/archivio/documenti/Innovazione/NotiziarioTecnico/2013/n3-2013/07.pdf.

disseminate the results obtained. As regards the possibility of obtaining energy efficiency during the services networks operation, it is necessary to highlight that this is possible employing ICT multiservice infrastructure as already described, because only the accessibility to consumption data of various resources by the various control systems allows implementing efficient operation of the various integrated infrastructures.

At worldwide level, the opportunities offered by the efficient use of electricity as an auxiliary service for water pumping are considered.

This is certainly possible thanks to the use of a multi-service network. A report of 2013 by EPA (Environmental Protection Agency, USA) shows what can be the savings achievable by a joint management of water and electricity. This because pumps are electrical machines and the use of the water resource can be addressed in times in which the electricity is cheaper and cleaner. This is certainly possible where there are water storage systems, from basins to service tanks for water storage built in Southern Europe in the years when there was a chronic shortage in the distribution of drinking water.

So the possibility of accumulating another resource different from electricity to achieve savings, may limit the use of electrochemical storage units, allows a better utilization of the electrical infrastructure as well as a reduction in energy losses.

6.3 Newly Built Cities: The Planning Approach Based on Layers

If in the case of historical cities one of the few possible infrastructural actions is based on the multi-service management and therefore on shared ICT infrastructure, in the case of newly built cities, it is possible to design the infrastructures layers also in order to optimize their management.

As for the objectives, the newly built cities can be planned to maximize their productivity in the case in which the vocation of the site is primarily focused on industrial production, or to maximize the efficiency of the offered services. In the first case [7], it is possible to:

- make efficient the economic infrastructure in order to increase the proportion of *low carbon* industries (producing while minimizing the greenhouse gas emissions), as service industries;
- update technologies to improve the environmental impact of production activities, especially for energy-intensive manufacturing.

An example of this approach is what has occurred in the production District of Shijingshan in Beijing in China. The main action was to remove the Shougang

Group, a major steel producer which contributed with about half of the tax revenue to the district and 40 % of air pollution in 2007.

The location of the steel producer in this case was strategically different from the perspectives of Beijing city district development, where the focus had become the service industry and high-tech manufacturing. For these reasons, in 2005 the closure of the steelworks group started and in 2010 it was completed. The increase in the proportion of service industries has led to a sharp reduction in emissions and an increase in the contribution to GDP of the district that has doubled between 2001 and 2010. The reprogramming of the territory on the basis of the services it offers, both if it is a productive area or if it is devoted to social and welfare of citizens, can be carried out in a layout approach [7] or in layers. The territory is then imagined as a set of nodes in which some urban functions are oriented to industrial production or to citizen-oriented services, or even to both.

Where not already been defined, or if, as in the industrial case, it can be easily redefined, the number of nodes that achieves the goals of:

– satisfying the needs of citizens
– reducing greenhouse gas emissions,
– achieving economic goals;

that number may describes the optimal size of the city district. The main measure is to use spatial optimization of the territory and the corresponding allocation of urban functions, targeted to avoid nodes providing unnecessary services (e.g. mobility), to reduce the proportion of mobility on wheels in relation to total mobility and to increase public transportation.

Moreover infrastructures can be optimized, reducing redundancies and errors even for what concerns the power, water and gas. An example of this approach is the eco-city of Tianjin in China, which is a urban area of new construction in which mobility is planned thinking of public transport like the skeleton and soft mobility as blood vessels, the objective of the project was to minimize the use of private cars.

Another example is the Yujiapu Financial District always in Tianjin, whose construction began in 2009 and will be completed in 10 years. The approach used led to the following design decisions:

- all buildings are technologically advanced and allow the saving of water and energy;
- an underground system connects the buildings to a subway;
- heating and cooling are centralized and employ advanced technologies for energy storage and for the reuse of waste;
- careful planning of housing to accommodate workers in the project avoids the waste of energy for the construction of temporary housing.

6.4 Multi-carrier Energy Hubs and Urban Districts

The infrastructure layer of an intelligent community can be founded on the integration and implementation potential with the other infrastructures supporting the basic urban functions. As proposed by Martin Geidl in his PhD dissertation [1], the concept of Hub, reproduced in the figure below, implies such possible integration. There are a number of facilities that can be modeled as energy hubs, as an example:

- limited geographical areas (rural and urban districts, towns, cities),
- power generation plants (cogeneration and trigeneration),
- industrial plants (steel works, paper mills, refineries),
- large buildings (hospitals, airports, shopping malls),
- islanded power systems (physical islands, trains, ships, aircrafts).

At the outset, the approach based on energy hubs was developed for greenfield design studies [8, 9]. Along the years, however, the concept has been used for other aims. While for most applications in the above list something can be found in the literature [10, 11], for urban districts, this approach is rather new.

In the following Fig. 6.1, a graphical representation of the idea is given in an urban context.

Wastewater, electricity, natural gas and biomass are all energy carriers that can be used, delivered, stored and transformed to produce non drinkable water,

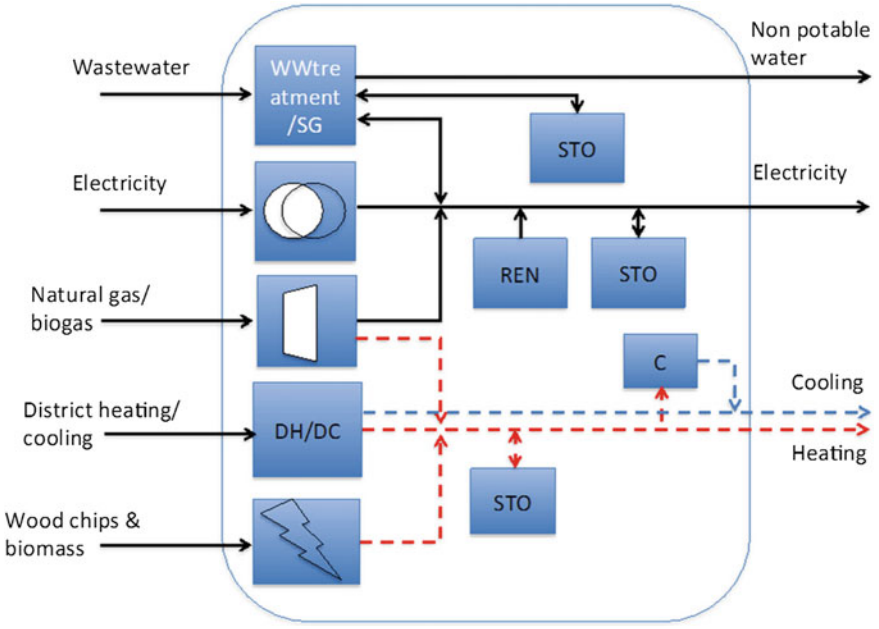

Fig. 6.1 Multi-carrier energy hub in urban districts

electricity, heat or cold. The perspective is that to reduce the environmental impact of the whole energy system, limiting recourse to Lithium-ion electricity storage and increasing the flexibility in the use of electrical energy and natural gas. In this way, the demand for both resources can be adapted to the distributor's or the market operator's best offer with a new multi-service 'demand-response' scheme.

From a systemic point of view, indeed the flexible combination of different energy carriers, thanks to the use of technologies for conversion and storage, allows to obtain the following advantages:

- Improving Energy Efficiency and reliability
- Increased flexibility, security and availability of power
- Optimization potential by:
  - reduction of energy costs
  - reduction of emissions
  - reduction and/or cancellation of congestion on infrastructures.

About the first issue, indeed, accounting for many inputs flows of an energy hub, that can be used to satisfy the demand at the output section, clarifies that the hub in general increases availability of energy for customers, because it does not depend anymore on one infrastructure [12, 13]. Actually, this effect can be limited, since certain infrastructures are dependent on others, i.e. the various inputs of the hub are not totally redundant.

Besides that, almost all modern infrastructures are dependent on ICT networks, for example multi-service supervisory control and data acquisition systems, which are in turn supplied by electricity.

As far as the second issue is concerned, redundant paths inside the hub offer a certain degree of freedom in the loads supply. Consider, as an example, the electrical load in Fig. 6.1. The latter can be supplied by electricity directly from the electricity input or by generating part (or all) of the load power using the gas turbine or even, in the medium term, using Salinity Gradient, SG, technology (Reverse ElectroDialisys or Pressure Retarded Osmosis, RED or PRO) [14]: a way to produce electricity using salt and water (wastewater treated by means of Membrane BioReactor, MBR, technology[3]).

The hub can thereby provide an alternative to an unattractive energy carrier, for example high-tariff or extremely polluting electricity. Thus the load appears to be more elastic in terms of price and shape, even if the actual load at the hub output remains the same.

[3]Membrane Bio Reactor is a technology for wastewater treatment that has been already deployed in many cities. The term is used to define wastewater treatment processes where a perm-selective membrane (microfiltration or ultrafiltration) is integrated with a biological process—a suspended growth bioreactor. All commercial MBR processes available today use the membrane as a filter, rejecting the solid materials that are developed by the biological process, resulting in a clarified and disinfected product effluent.

About the third issue indeed, the possibility to deploy different combinations of different inputs to meet the output requirement provides a large optimization potential during operation. The different inputs are characterized by various costs, emissions, availability, and others. In this way, the input flows can be optimized using the additional degree of freedom established by connections that are redundant.

The synergic feature of the energy hub is intrinsic in the use of different energy carriers showing different features. Electricity, for example, can be transferred over long distances with comparably low losses. Chemical energy carriers can be stored employing relatively simple and cheap technology. Gaseous energy carriers can, to a certain limit, be stored in the network by using gasification units. Transmission and storage characteristics as well as other specific features of the various energy carriers can be combined synergetically.

When thinking of urban applications however the available space and volumes for the installation of the energy hub components (generators, storage units, conversion units, etc.) must be accounted for and such features strongly depend on urban features, such as the construction year.

Recently, some applications show the viability of the possibility to model urban districts as energy hubs [15], although a support at regulatory level would be needed. The district would become an entity, a single energy system and an ICT platform should grant users access to their profile, registering their availability to join promotional programs and provide flexibility of consumption.

The Netherlands seems to be at the forefront of experimentation in this field.

The Dutch project 'Transition in Energy and Process for a Sustainable District Development' focuses on the transition to sustainable, energy neutral districts in 2050, particularly in energy concepts and decision processes. For this reason some pilot districts have been identified in the country.

Since 2008, the Municipality of Almere[4] together with William McDonough and Partners developed "The Almere Principles", a green paper about urban sustainable development expressing design guidelines for the future growth of the city. The Kruidenwijk residential area in the city of Almere with more than 8000 people since 2010 has been selected for upgrading of the district heating network with high temperature heat using geothermal energy or other low impact tehnology such as biomass cogeneration plants.

As Almere is preparing for the "Floriade 2022"[5], the city is applying the Principles to the development of the exposition site, and more broadly, to the realization of its expansive Growing Green Cities vision. The conceptual framework for the development, informed by circular economy thinking, helps to translate the Principles into practices and support the evolution of Growing Green Cities. "Recognizing the interdependence of city and nature sets the course. When the natural processes that support life—the currents and flows of the water cycle;

[4]A young city within the metropolitan area of Amsterdam, built on land reclaimed from the sea.
[5]The World exposition to be held in Almere in 2022.

the transfer of nutrients in healthy soil; the webs of life in gardens, forests and seas; the energy of the sun—inform the design of cities, urban growth is verdant and regenerative. To create the conditions for regenerative growth, Cradle to Cradle[6] thinking applies the intelligence of natural systems to human designs, envisioning green cities as living metabolisms, powered by the energy of the sun, in which two discrete nutrient flows—biological nutrition and technical nutrition—support healthy, diverse, delightful urban communities[7]."

According to [16], Apeldoorn shall become 100 % energy neutral in 2035. The Apeldoorn municipality indeed points at an all-electric concept with small-scale district heating networks if needed. Folowing the Masterplan, Kanaalzone Noordoost district is being restructured until 2025. The district hosts a mix of existing buildings, newly built housing and smallscale industry. A part of the Kanaalzone Noordoost will serve as a recreational area. A channel flows through the whole district. The present industrial buildings are being substituted by offices and dwellings. Int his way, the Apeldoorn municipality wnts to implement a combination of living and working while preserving the small-scale character and cultural, historical and natural values.

Biomass and domestic waste will be transported to the biogas generation units outside the district. The biogas will be upgraded to natural gas quality and transferred back to the district where it will be turned into heat and electricity in combined heat and power installations.

In Apeldoorn Zuidbroek 117,000 m^2 of low rise buildings have been constructed, in large part they are dwellings, but also a large community center.

The neighborhood has the following recent features [17]:

- Energy performance coefficient[8] of buildings (EPC—shell based) of 0.8, together with the bio-energy based district heating system, the EPC is targeted at 0.64.
- 2.65 GJ additional energy savings per dwelling per year (e.g. 400 Wp solar panels/dwelling).
- District heating Zuidbroek (2500 dwellings).
- Sewage digester, with poultry sludge (1.5 MWe).
- Woodchips peak boiler (2.8 MWth).

Figure 6.2 shows the set up of the energy system of Zuidbroek. The waste water from the dwellings flows into the waste water treatment plant (BCFS, namely,

[6]The Cradle and Cradle principles were ideated by Prof. Michael Braungart and William McDonough and further developed by EPEA (Environmental Protection Encouragement Agency), a consultancy company in environmental issues residing in Hamburg.

[7]https://floriade.almere.nl/fileadmin/files/floriade/EN_floriade_expo_Milan_LR_-def.pdf.

[8]The ratio of actual to expected energy consumption turns out to be a very well-behaved and versatile measure. A value of unity is neutral: it signifies that consumption is the same as would historically have been expected, given the current prevailing conditions. Greater than one signifies poor performance—higher consumption than expected—while a value less than 1.0 indicates improved energy performance.

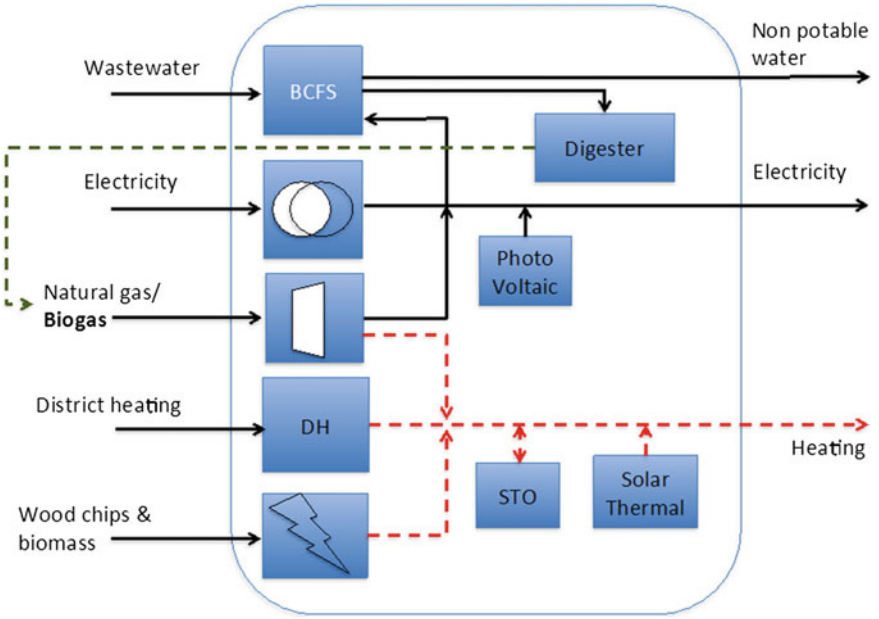

Fig. 6.2 Set up of the energy district in Zuidbroek (NL)

Biologisch/Chemische Fosfaat en Stikstof verwijdering[9]); after dewatering, the sludge is digested and the biogas is burned in a cogeneration plant (Combined Heat and Power, CHP) generating electricity that is used for the pumps of the waste water treatment plant. The CHP is used for the district heating system. To cover peak demand, additional boilers will be used to produce heat based on biomass chips and/or natural gas. Photovoltaic and solar thermal panels are an integral part of the project, and are installed on dwellings as well as on the peak boiler building and the office building of the district.

Still in Denmark, the project of the Municipality for Hillerød has been changed significantly since the beginning. At the start, the project was concentrated over 79,000 m^2 of low energy dwellings for single and multi family use in the district of Ullerødbyen. However, due to the financial crisi, a strong reduction of the renovation of private homes in Hillerød as well as in whole country took place. Against this background, the project's focus was enlarged to the entire city of Hillerød and included also other building types such as office buildings. This change also led to a dramatic increase in the use of solar PV panels, which moved from around 8 kWp to over 400 kWp. During the project the following was realized in Ullerødbyen or its close vicinity:

[9]Biological treatment of wasterwater and sewage water.

- Low temperature district heating network.
- Solar thermal collectors (>3700 m^2) in two fields.
- 86 Class 1 Ecobuildings (−50 % below building code requirements).
- 20 Class 2 Ecobuildings (−25 % below building code requirements).
- Biomass boiler (6 MW thermal).
- Biomass gasifier (500 kW electrical and 1 MW thermal).
- Office buildings, city college and conference centre (total 27,000 m^2).
- Solar Photovoltaic panels (410 kWp). Additionally school buildings in a different district in Hillerød have been renovated (3000 m^2).

Although in Hillerød an efficient ICT monitoring systems has been implemented, a real integrated multi-carrier energy management has not been experimented and it seems that at district level this kind of implementation must still be carried out at world level.

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Chapter 7
The Role of Sharing Practices and Dematerialized Services in Smart Cities

Eleonora Riva Sanseverino, Raffaella Riva Sanseverino and Valentina Vaccaro

Abstract The "intelligent management" of living in cities and of the traditional urban functions, summarizes the model of smart city. Through new integrated approaches generated from the use of Information and Communication Technology (ICT) and of the web, which take the role of enabling technology for change, contemporary cities are strongly changing. The digital age creates, in fact, the conditions for the emergence of new tools and new services for citizens, based on communication and on sharing and participation practices. The chapter contextualizes these changes by focusing on some examples of what can be defined as "dematerialized services" of contemporary cities, seen as new urban services and new practices of communities living in smart cities.

7.1 Dematerialized Economy and City of Services

As far back as 2000, referring to a purely economic field, Robin Roy [1], spoke of the advent of a new era founded on the "dematerialization" of the economy, highlighting the emergence of a new "service economy" in which profitability would be based not on material production and on consumption, but on supplying services to satisfy human needs (i.e. in health and mobility). This change, in full line with current trends, would have led, as the author writes, to a lesser usage of resources and to a lower environmental impact.

In this context, the author distinguishes between:

E. Riva Sanseverino (✉) · V. Vaccaro
Dipartimento di Energia, Ingegneria dell'informazione e Modelli maematici (DEIM), University of Palermo, Palermo, Italy
e-mail: eleonora.rivasanseverino@unipa.it

V. Vaccaro
e-mail: valentina.vaccaro.pa@gmail.com

R. Riva Sanseverino
SmartplanningLab, University of Palermo, Palermo, Italy
e-mail: raffaellarivasanseverino@gmail.com

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- *result services* (also called on-demand products or services) aiming to reduce the material and the environmental intensity of existing systems by selling a "result" instead of a product (i.e. a company supplying copiers, can provide printing and delivery services to customers);
- *shared utilization services* (sometimes called product use services or community products), which have the purpose of increasing the use of the material parts of a system by sharing the products required (e.g. car sharing);
- *product-life extension services*, which are services that aim to significantly increase the useful lifetime of the products or materials through maintenance, repair, reuse and recycling, thereby reducing the amount of energy and resources to provide a given function;
- *demand side management* (sometimes called least-cost planning or integrated resource management), which is a concept born in the energy supply field which includes services often similar to those falling in the first category of "result services". In the energy sector, for example, the Energy Service COmpanies (ESCO) provide to their customers, typically users with significant energy consumption, different integrated services for the implementation and subsequent management of energy efficiency measures. These companies guarantee the maintenance of the plants and return part of the savings to the customer. In this way, by keeping the other part of the savings due to reduced energy consumption, they can both finance the investments and get remuneration.

What we might call then "dematerialized service/product" has as a fundamental feature of sharing and two-way communication. Certainly emphasized by the current period of economic crisis, the idea of owning something, whatever it is, is more and more replaced by the idea of sharing the use of something. Another highlight of this change in perspective is the increasing attention to the environmental impact of goods and services, which bring consumers, producers, citizens and administrations to put in place consumption and planning choices with lower environmental impact.

In view of all this, is it reasonable to have goods, if people can use services instead? Starting from the new possibilities derived from the information and communication infrastructures, it is possible, in fact, to reinvent the city and its services to make them more efficient in different ways.

All this leads to develop a new approach to the definition of the urban layers or of the urban infrastructures of the contemporary cities.

As a matter of fact, behind the services provided to the community there are the urban infrastructures, which, as noted, are traditionally divided into "urban hard and soft infrastructures". The first ones relates to the urban physical infrastructures, such as the supply energy system (electricity, gas), the water supply system, the wastewater treatment and discharge system, the waste management system, the public transport system, etc. The second ones refer to the decision-making and two-way communication; they are about the ideas that shape the community and that appear in all these regulatory tools and standards which define its founding principles of the same [2–5].

In the new concept of *smart city*, traditional infrastructures are largely changing due to the need to offer new services to the community and to citizens, and to maintain clear objectives such as high efficiency, low environmental impact and high adaptability to external changes (climate changes, urban development, new needs and factors affecting the quality of services offered to citizens, etc.) in the long term. In this context, the Information and Communication Technology (ICT) and the digital space (understood in its literal and figurative sense, as the set of data you collect and process in the web or through sensors in real world), performs the role of enabling technologies. A reading of this concept, as already seen in the previous chapter, can be found in the layers model of Smart Community recently proposed (2014) by the International Organization for Standardization (ISO) in ISO/TR 37150: 2014 "Smart community infrastructures—Review of existing activities relevant to metrics" [6].

The model shows a hierarchical structure in which, those that the ISO/TR standard defines the different dimensions of the smart city (Table 7.1) are deployed at the different levels.

The model is based on the assumption that, behind the services provided to the community, there are the urban *community infrastructures* (ISO/TR identifies only the hard infrastructures), as fundamental and shared technologies to support the delivery of the other two services layers (facilities and services).

Looking at Table 7.1, the Community Services are thus built on top of the Community Facilities, that rely on the Community Infrastructures, the so called hard infrastructures.

Focusing on what we called "hard urban infrastructures", the International Organization for Standardization, already in February 2012, had started to work on standardizing "Smart Comunity Infrastructures" [7, 8], which coincide with the infrastructures at the lowest level of the proposed model.

The standard addresses the technical aspects of the Smart Community, dissecting the concept of smartness in terms of performance and technological solutions that can be implemented and integrated to create a multi-service infrastructure. It does not focus on dealing with specific standards for each infrastructure.

The Smart Community Infrastructures, then, are defined as infrastructures to minimize environmental impact, increase economic efficiency (for example in the management of the provided services) and provide services that improve the quality of life of citizens. These objectives are achieved using ICT like sensors networks and the Internet of Things technology, which links smart objects[1] to the Internet, data transmission systems, actuators network, and renewable energy systems in order to achieve an integrated and optimized management of the same infrastructures and of the relevant provided services [9].

[1]Smart objects are equipped with sensors and have bi-directional communication ability. IoT can enable an exchange of data never available before, and bring users information in a more secure way.

Table 7.1 Layers model of a Smart Community in ISO/TR 37150:2014

Layers	Examples of functions
Community services	Education, healthcare, public safety and security, tourism, etc.
Community facilities	Residences, commercial buildings, office buildings, factories, hospitals, schools, recreation facilities, etc.
Community infrastructures	Energy, water, transportation, waste, ICT, etc.

Table processing from [6]

Examples of measures and actions implementing this concept are becoming more and more common, partly because of the strong pressure from the European policies and European funding current address (e.g. Horizon 2020).

For example, more and more often, traffic light systems transmit information about the vehicle traffic and are able to change the timing of the lights of traffic regulation (green and red), to ensure that cars are always on the go (this brings environmental benefits, in terms of reduction of environmental pollution, and benefits to citizens, in terms of saving in time and costs). A system like this uses sensors, video devices or electromagnetic coils embedded in the asphalt, to receive monitoring data of the traffic from the roads (Community Infrastructures). These systems allow to detect the intensity of the traffic flow, they can process the data collected and, for example, send information about the number of cars and their speed in the controlled area to citizens (Services Infrastructures). The supplied data allow the local administration to implement policies of traffic management tailored to specific areas of the city, this gives environmental and governance benefits (Services Infrastructures).

Detection systems, such as video units, coupled with identification systems (sensors) installed on the private cars, also allow the control of the area, increasing the safety and allowing, for example, the identification of number plates both for the purpose of fining those who have incorrect behavior both in order to identify cars of criminals.

Within the layers of services, as explained until now, the digital infrastructure and ICT takes the role of transversal infrastructure, which enables the transition from the traditional "hard urban infrastructures", to the "smart hard urban infrastructures" (Fig. 7.1). The platforms and services built on top of the ICT network, however, are also "soft urban infrastructures", which, in the smart city, can be identified with the set of intangible services/products, that arise from social interaction, by the desire to solve a shared problem or develop an idea to provide a service to the city or to the citizens.

The process of development of these new intangible, dematerialised, services (traditionally understood as what concerns the institutions and regulations, now evolving into services offered by citizens for citizens, such as crowd-sourcing, car sharing, etc.) within an undefined set of persons not previously organized allows the transformation of citizens into agents providing a service by means of connectivity.

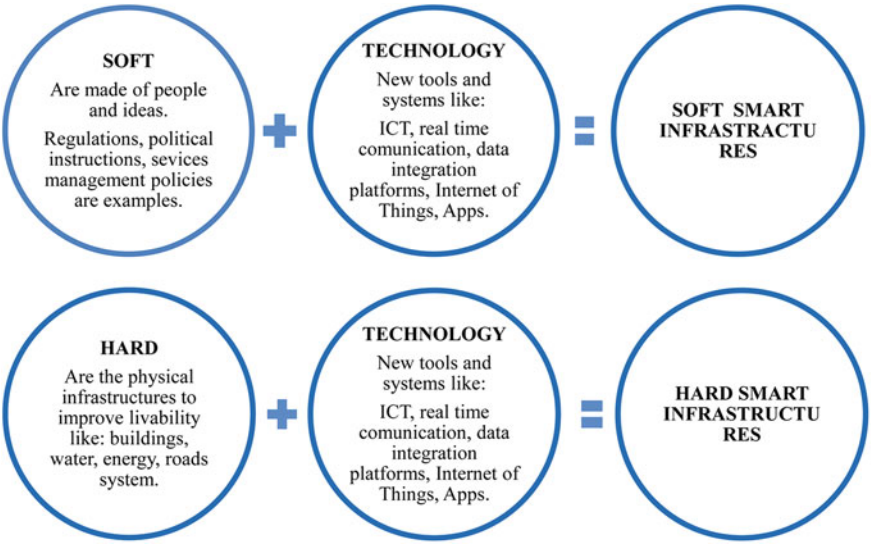

Fig. 7.1 How can infrastructures become smart?

The encyclopedia Wikipedia is a concrete example of how the sharing of knowledge from free actors can provide a service to the community.

In the following sections some other examples of these dematerialised services is given.

7.2 Communication and Sharing in Smart Cities

Communication, together with sharing, has become a *place* of the contemporary city. The experiences of co-working spaces[2] are definitely a concrete example of a social innovation *place*. Sharing equipment, information systems, knowledge and skills are the ingredients to make sure that co-working *places* become a multiplier of capital gains [10]. Such spaces have been increasing rapidly throughout the world (in 2015, 7800 spaces existed worldwide with a growth rate of 83 % from 2012 to 2013 and of 36 % from 2014 to 2015 [10]). An interesting ranking of the best global coworking spaces for the 2016 is reported in [11] from it we can note how the best ones are much more than a shared office space. They not only create ideal places to get work done, but they are also creating centers for innovation and create outstanding local networks of like-minded founders.

The tangible productivity and the benefits that may result to the community in terms of employment levels and offered services, is so remarkable that, for example,

[2]Coworking spaces are shared office environments for independent professionals.

some Italian regions—such as Tuscany—support young people who want to start this new type of business model that is almost at zero management costs.

Many *startups* are indeed borned within co-working areas. Laboratories are often digital innovation Lab, as Applico Digital Lab [12]. It is an infrastructural pole for digital innovation, created by the strategic vision of four Italian ICT companies in the Umbria region. The idea is to aggregate innovative visions and "digital" professional profiles to promote the development of synergic projects by sharing workspaces, training proposals and targeted events. Each Applicant or APPLICO coworker, in addition to the potential offered by a work environment based on the sharing economy, with excellent facilities in terms of network connectivity and infrastructure support, can rely on a dedicated tutoring service, able to support the development of its business, from obtaining funds to being introduced into relational networks.

Sustained by strong innovations within Information and Communications Technology (ICT) and Social Networks, citizens are changing way of thinking and habits, as reported by field studies.

Politicians, businessmen, but also ordinary people evaluate the importance of the communication of every day activities and rely more and more confidently on the web. Even the Pope [13] has already innovated strategies and ways to communicate with believers and non believers, shortening the distances through the use of digital technologies.

Following economic or sociological metrics, the Internet is one of the most important technical infrastructures existing today. A simple measure of the impact of the Internet and the importance it has within the contemporary community, is to consider the number of users, which since June 2010 was of 2 billion, while from an economic standpoint, in 2010 the turnover of Internet companies in the US alone was more than $ 70 billion.[3]

The wave of political protests that hit Egypt in 2011, gave an indication of the impact that the Internet has in sociological terms. Besides it is well known that thanks to Social Networks, citizens have found new channels to get in touch and try to break the power games.

The limited use of Internet and of Social Networks (Facebook and Twitter) blocked by authorities in Egypt turned to be totally inefficient to prevent the exchange of information among the opponents. It is interesting also to note that the power of the Internet is here measured in a country where Internet penetration in 2011 was 21 % (79 % was in 2011 in Germany) [14, 15].

And again, an interesting study carried out by Cisco IBSG yet in 2011 [16] forecasted that the devices connected to Internet would reach 25 billion in 2015, and 50 billion in 2020: it is surprising if one considers that calculation is based on the entire world population, much of which actually does not have an Internet connection.

[3] https://www.bcgperspectives.com/content/articles/telecommunications_connected_world_growth_global_mobile_internet_economy/.

In Italy, for example, the data provided by ISTAT[4] on the sample of individuals statistically representative of the Country, tell that in 2014 over the previous year, the share of households with access to the Internet from home and a broadband connection was increased (respectively from 60.7 to 64 % and from 59.7 % to 62.7).

The Italian scenario shows that families with at least one minor are the most technologically equipped, while the digital gap is stable between the north and south of the country (the families of the center-north, who have a personal computer and access to the Internet from home are about 66 %, compared with 57.3 % of equipped households in the South). As compared to 2013, the use of personal computers is stable, but increases the daily use of the web (+3.3 percentage points). In fact, the widespread diffusion of the last generation mobile phones allows citizens to become consciously or unconsciously receptive sensors [17] of a constantly changing and moving city, being able to record different situations and compete with their behavior to a better operation of urban services.

It is well known that the concept of "intelligent cities" has attracted considerable attention in the context of urban development policies. Internet, sensors and broadband technologies increasingly take on the role of enablers of services for urban development, as cities are increasingly taking on a key role as drivers of innovation in areas such as health, social inclusion, environment and enterprises [18].

The advent of the digital era, in fact, has radically transformed our way of living allowing the development of new tools activators of urban welfare through social participation and innovation [19].

While, to date, the key role of cities and regions in terms of innovation was mostly focused on the widespread integration of broadband infrastructures as much as possible distributed throughout the territory, today's cities are considered not only as the object of innovation, but as an innovative ecosystem which allow through the ability to co-create the community and the participation of users and citizens, to develop "smart" projects and actions.

7.3 Mobile Apps and Citizens as "Enabling Tools" for Dematerialized Services

It is in this context that more and more new intangible services are developed in the "management of living" through the use of smartphones and tablets and through the development of mobile Applications (Apps) that are user friendly and open source data. In this way, citizens can be receptive sensors and provider/user of services; this comes back to the idea of prosumer (producer/consumer) that is already a consolidated issue in the energy sector.

[4]ISTAT: The Italian Statistical Institute, it is a public research institution. Present in the country since 1926, it is the main producer of official statistics in support of citizens and policy makers. It works independently and in continuous interaction with the academic and scientific world.

An interesting article [20] addressed the concept of sharing economy reporting the example of some of the most popular apps used in the world. These offer those who, previously, we have referred to as *shared utilization services*, even creating business alternatives and works. Nowadays, in fact, you can easily share any goods, such as a house (Airbnb app), a car (Uberpop app) or a meal (Gnammo app). The benefits of a so structured economy are to help to recoup the costs of management of the property owned, as well as to offer the added value of the exchange of experiences and knowledge that these services indirectly give. The success of an app or a web platform is the feedback, which is a way to communicate their own experiences to future customers/users. Review (like sharing an experience) becomes the driver that triggers curiosity and involves the community.

Fabio Era [21], senior researcher at Ipsos, asserts that "the novelty, innovation, environmental sustainability and ethics which are implied in the sharing of goods and services, are the real factors determining the success of the Apps".

Services based on sharing are becoming common and work so good that, in all the State of Oregon, USA, the municipal administrations share, via a digital platform, heavy vehicles for road maintenance [22], the advantage of this is that the single administration should not necessarily have all the heavy vehicles necessary for the maintenance with the consequent economic benefits. The sharing economy, thus reinvents the concept of ownership coming to what Rachel Botsman [22] called collaborative consumption, which is based on trust.

The process, as mentioned, is made possible by tools such as *open data*, *cloud computing, Internet of Thing* and *Apps*.

Applications for smartphones (Apps), in fact, are an instrument that has begun to offer the market some 15 years ago, but only in recent years has become a mass phenomenon that involves citizens, young and old, and the local Administrators.

Apps development is an area that, to date, has a turnover of several billion dollars and above of millions of developers and users.

The "smartness" and the benefits of this tool are:

- it can be developed with moderate investments (the average development cost is about 1.000–5.000 €) [23, 24];
- it can be developed even not having domain-specific skills. One can indeed rely on a freelance, on an agency or on a "do it yourself" services which allow a cross-platform development (it is a software development mode which is independent of the operating system and which allows the production of Apps usable on most systems) without having to know programming languages;
- it offers the possibility of using open source data. Many apps are using open source data provided by the municipal government (e.g. a lot of Apps made by the municipality of Bologna city in Italy) or they can interface with the most common free data platforms such as Google Map.
- it provides services to improve the daily citizens quality of life. Apps offer, in fact, innovative response to the real and concrete needs of citizens. The idea of developing an app, in fact, often born by citizens themselves that share a problem and invent a way to have a simple and immediate benefit;

– it is a horizontal tool (data shown above regarding the use of the web and Smartphone in the worldwide population, give an indication of the potential users of such tools);
– it enables public administrations to shorten the distance with citizens, offering the opportunity to engage them and get them involved in the management of the public goods.

It is thanks to the combination of all these benefits that public administrations are increasingly considering apps as operational instruments whit an equal role in the urban development of the traditional measures (e.g. local regulations and development of physical infrastructures).

The first experiences concerning the use of the Apps in the management of urban services, also well date back to a few years ago and refer to the cities known as "precursors of the concept of smart city" (city that for over a decade, implement alternative ways of running the city, keeping under constant review the level of greenhouse gas emissions) such as Stockholm, Amsterdam and Singapore.

These were, for example, the first cities that, through the data picked up by mobile phones of citizens have experienced new ways to manage the traffic.

If we refer to the smart city measures, we can find projects that use Apps in all six areas of the "smart city" (smart economy, smart mobility, smart environment, smart people, smart living, smart governance), a perfect example of this is the case of the city of Bologna, Italy.

The city of Bologna, as already seen in the previous chapters, today has the second place in the in the ranking of the smart Italian cities, second only to Milan [25].

In its first phase of work (2011), the city, through the platform Bologna Smart City, has identified seven key areas on which to develop their own smart measures and collect membership from institutions and private companies in order to create partnerships for specific actions.

Among the identified areas, the establishment of *Iperbole 2020 Cloud & Crowd* was included. This was referring to the redesign of the *Civic Network* [26] called *Iperbole* (it was created in 1995 and was among the first civic networks promoted by a Government in Europe, it was also the first in Italy among those promoted by municipalities; *Iperbole* was initially focused on free access to Internet for citizens and was later developed on public services for citizens).

The Digital Agenda (presented in Europe in May 2010), which has precisely defined objectives to develop the economy and the digital culture in Europe, as part of Europe 2020, constitutes one of the seven flagship initiatives of the strategy. In fact, it has started the construction of the new "Civic Network Iperbole".

The Administration goal in the re-design of Iperbole, was to create an open communication and information tool, a space devoted to providing digital content, a continuous story about the society, a platform which could aggregate and intercept the stakeholders' needs, harmonizing and representing the dialogue with the city.

Between 2011 and 2012, the Municipal Administration has initiated a process of reconfiguration of its online presence. The Public Administration has held steady at

a policy of investment in infrastructure, focused on reducing the digital divide and build a broadband network linking government buildings and schools.

In the same time it was decided to keep active the institutional portal and open new channels of communication, specially dedicated to ideas and events (including the Digital Agenda Iperbole 2020).

The Civic Network Iperbole 2020, to date, is a single online platform due to the main domain of the City of Bologna which has a cloud infrastructure. The platform, via which you can also access to all the municipal open data, is the area of digital services to citizens, is the institutional communication area and the one which is dedicated to the contents generated by users.

A report of the Bologna municipality [27] points out that the residents and the city users have shown a strong sensitivity to the web and to technology, going to make a great demand for services, presented in the City's platform, and going to ask a lot of constantly changing applications.

Here there are some of the dematerialized services offered to citizens by the city of Bologna.

"Smart Governance App" example

The Bologna's community, stands out, in Italy, for its interest in the collaborative mapping and in the active policies for the common good. Bologna infact has the highest concentration of data mapped by the citizens through digital devices, on Open Street Map [28].

Probably considering this support from citizens, the Municipality of Bologna in 2013 invited citizens to contribute to the mapping of the municipality abandoned buildings (Impossible Living Project) with the aim of return them to the citizens.

The buildings were included in the Municipal Open Data and have been distinguished in: unused buildings to be valued are buildings for which the City already has a project awaiting funding; business premises, such as shops and warehouses, which are waiting for being rented and purchased to start business activities; unused buildings for which there was no planned new use. Through an open data application also usable by mobile phone, the municipality has opened an online consultation to the intended use of the municipal unused buildings, involving citizens in proposing ideas and projects in order to return these public spaces to the use of the community [29]. Thus the future destinations of the buildings and spaces would respond to meet the real needs of future users, citizens precisely.

"Smart People App" example

The BazzAPP is a digital platform aims to create new methods of interaction between the Bologna's citizen, the City and its public and private infrastructures, through a system based on two elements:

– the BazzAPP, are temporary mobile apps which represent those exciting opportunities that companies, institutions and organizations make available to users, even for limited periods;

– BazaaR, a platform that aims to spread the BazzAPP to users at the time and right place even through the Augmented Reality.

The BazzAPP service, offered by the Municipality of Bologna, by notification on the mobile phone and depending on the position in the city and on the profile of the registered user and according to their movements and needs, notifies the apps available in any specific time of the day [30].

The development of this service by the municipality, emphasizes the digital policy is one of the main axes of the development of the smart city of Bologna.

"Smart Mobility App" example

The company that operates passenger transport in Emilia Romagna, the region in which Bologna is located, has chosen not to develop their own applications for mobile devices, but to make available data on service Open Data allowing others to develop software and applications. This choice has already given rise to various apps. Among the most interesting "MiMuovoSmartCity" [31]. Made within a project funded by the European Commission, by the City of Bologna, by the Emilia-Romagna region, and by a private company, it aims to aggregate within single platform different web traffic services for the city of Bologna. The App allows citizens to find in a single portal, also compatible with smartphones, the information needed to move.

The information layers displayed on Google map are:

– about the bus stops, in Bologna and its province. It brings, in real-time for each one, the arrival time, through a GPS tracking of the buses. It also shows the closer shop to the bus stop where to buy tickets;
– about the traffic. Through the monitoring system of vehicular traffic the App displays the status of the traffic on the main streets of Bologna (updated every 5 min). Different colors indicate the level of congestion on the roads. The App reports also the main traffic problems such as road work in progress, shrinkage of the roadway and traffic congestion;
– about car parks. It, in real time, displays the main public car parks with details of vacancies, and information about rates and available services. There are also the positions of the parking meters;
– about bicycle paths. The map shows the network of cycle paths, specifying the type of the various pathways (e.g. pedestrian path, promiscuous vehicular etc.) and bicycle rentals;
– about security. Map shows the positions of the cameras for access control (Restricted traffic areas, the old town, reserved lanes, etc.);
– about accessibility of the public places. The App provides information on the level of accessibility of public places (e.g. pubs and offices). Information is provided by the citizens in cooperation with the portal "Liberi di Muoversi" ("Free to Move", at is the portal of the city dedicated to giving information to people with disabilities);

– about general information. In the portal you can search for days and hours of the night cleaning of the streets in the historic center of Bologna. The service is provided by the company "Hera Group".

The development and the success of this apps is the symbol of what the citizens identify the time factor as a key element for assessing the quality and efficiency of services. So their development is a necessity accompanied by a growing demand for efficient mobility and simplification of the road transport services. It is interesting to note as the system combines within it the contributions of the various stakeholders (citizens, municipality and private companies) in order to provide a service as complete as possible. The interoperability of the data used in the service offered by the App and the ability to be continuously updated in real time are other advantages of using these instruments for citizens.

"Smart living App" example

The social inclusion of disabled people, has always been an indicator of the livability of a city. One of the great achievements of the digital age and of his being "horizontal" is to facilitate the overcoming of some trumpeting that disabled people have in the use of some urban infrastructures. In accordance with this principle, and in collaboration with the Municipality, the Uildm (Italian Union for the fight against muscular dystrophy) has developed "Accessibol", the app that lets you find the entertainment premises of Bologna which are accessible to wheelchairs. Through an interactive map, the app provides information on georeferenced barrier of the entertainment premises (for example the presence or absence of steps at the entrance, parking suitable for persons with disabilities and their distance to the location where the user is) [32].

The platform can be implemented through the reporting of the same users, implementing the collaborative process to the use of a service that is one of the aspects of the new dematerialized services of the smart city.

7.4 The New Frontiers of Urban Sharing: Sharing Mobility and Energy Services

Some experimental projects in some European and non-European cities are based on the new possibilities deriving from the use of ICT to optimize urban functions and services (energy and mobility). Apps and Internet of Things, IoT, technologies are driving this tremendous innovation.

The new frontier of IoT networks will be dealing with billions of devices connected over wireless networks. IoT may now be a hot topic in the industry but it's not a too new concept. In the early 2000's, Kevin Ashton at MIT was laying the groundwork for what would become the Internet of Things (IoT). He conceived this idea as he searched for ways to improve Procter and Gamble's business by linking

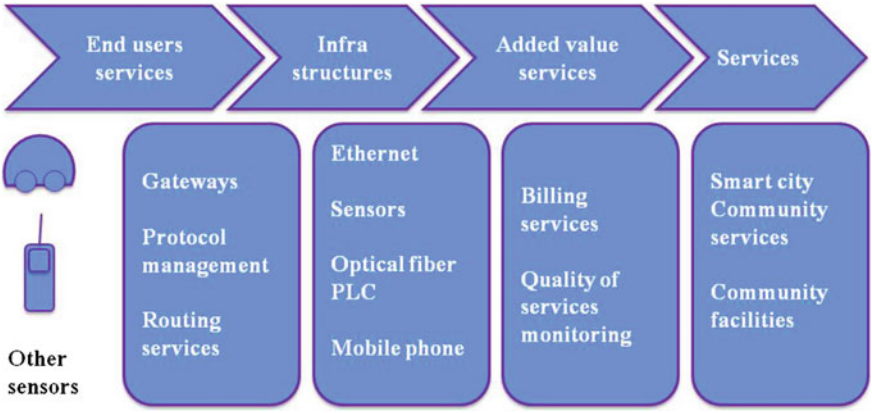

Fig. 7.2 Internet of things in smart city

RFID information to the Internet. The concept was indeed simple and powerful. If all objects in daily life were equipped with identifiers and wireless connectivity, these objects could be communicating with each other and be managed by computers.

Most IoT applications are today devoted to the urban community services, facilities and infrastructures management (Fig. 7.2). Mobility, as an example, may use a connected car environment. Such environment exploits the on-board sensors or the smart phone sensing potential.

Modern vehicles are indeed embedded with varieties of sensors monitoring diverse components as well as the driver's behaviour. As vehicles will be connected over wide-area wireless networks, many of their performance-data along with localization data and user-behavior information will be open to the automotive Original Equipment Manufacturers, OEMs, and aftermarket vendors. This data provide a rich source of information about vehicles and drivers behaviour. Once these data are combined with contextual data about environment, location and the driver, they may give many new possibilities also to third parties, such as consumers market, insurance industry, car repair chains and car OEMs. Part of the data analytics can be carried out at local level both using on-board systems or smartphones to optimize the communication.

Kargupta said: "Like most other industries, technical and business processes in the automotive and transportation industry have been traditionally analyzed, understood, and modeled based on limited amount of empirical data and the contextual domain knowledge. Availability of massive amount of data is putting the existing understandings in new light, posing new questions, and creating new possibilities that were not possible before. "Big Data" are changing how we make vehicles, how they work, how we use them and how they interact with everything else in this world. From vehicle-manufacturing to warranty management, insurance underwriting to dealer CRM, and traffic modelling to route optimization, Big Data

is changing the world of automotive/transportation industry and beyond. Typically, analytics for connected cars can be categorized in two groups" [33].

Mobility and urban transportation, through sensor networks, wireless communication and data analytics potential for managing "Big Data", are in this way reinvented and made more functional and smart. One part of the IoT game in cities are also smart phones, considered as travelling monitoring stations that can register data about the process to be studied and the environment and can transmit them through GSM technology.

The Mobiliti360 App in the US is all about safe mobility, fun, and earning from gaming and insurance systems. The website, www.mobilit360.com includes a lot of services for the users, but also an open API[5] architecture that allows anyone to build an application (a new App) on top of the already existing developers platform.

Basically, Mobiliti360 allows to

- Log the trips: automatically keeps track of all trips after installation.
- Keep an eye on the school bus rides of kids.
- Check where your family members are
- Check where we go: Mobiliti360 also shows the popular places in the city where other people are going. This feature also shows you the common places where you go.
- Team up and insure: Mobiliti360 Safe Driving Program makes ensurance a rewarding experience. If the driver scores above a given threshold, he/she can purchase auto insurance through the Mobiliti360 partner insurance carriers.

In July 2015, the Index Ventures company [34] invested 100 million dollars in BlaBlaCar [35] the sharing mobility community with more than 8 million subscribers in 12 countries (including Italy).

Last year Zipcar—the US car sharing service recently activated in Canada and in Europe—has been acquired by a car rental company, AVIS, for 500 million dollars.

The private mobility is one of the sectors in which the inefficiencies are no more sustainable: 70 % of travelling in cities is made with private cars. Car stay under-utilized in parking lots for more than 70 % of their lives; when they are used, on the average, no more than 30 % of available space is employed [36].

Sharing a travelling route through *sharing mobility* is nowadays a possibility provided by citizens through web-connected platforms. In Naples (Italy), the service offered by Bee [37] allows to take the vehicle in one area of the city and leave it in another place.

Bee does not require to travel with other people and cars provided by the company are ecological, namely electric vehicles. To use the service it is required to subscribe to the Bee platform, which allows to get in the Limited Traffic areas of the city of Naples and to park everywhere for free. The car can be booked at a Bee

[5]Application Programming Interface. It indicates any set of procedures available to the programmer, usually grouped to form a set of specific tools for the accomplishment of a specific task within a certain program. Often this term refers to the available software libraries in a certain programming language.

point or directly in the parking areas. The rate is triggered when the car is taken, and it stops when the race ends. This means that only the actual usage of the car is paid.

The yearly cost of the subscription is limited and ranges around 30,00 €.

Shar'ngo [38] is a national Italian platform for electrical and sustainable mobility managed by Car Group, offering floating car sharing services with profiled tariffs in the largest Italian cities. The differentiated tariffs are a particular feature of Sharn'go and they are created based on the lifestyle getting to 50 % discounts. For this reason, the cars are called as 'fair' cars (Equomobili), with the ambition of turning car sharing into a mass habit.

Share'ngo rents electrical and high performance micro-cars 100 %, with autonomy of 100 km and citycar equipment: 2 seats, 300 lts storage and on-board computer with a navigation system. Produced by Xindayang of the Geely Motor co group, these micro-cars are designed in Italy and CS GROUP has acquired the competences to implement energy and mechanical technologies for their development.

In the field of bike sharing [39], Bikemi offers an efficient service in Milan (Italy). Active 365 days per year Bikemi is healthy for users and typically operates from 7 to 24. To encourage the use of the bike, Bikemi delivers the first 30 min of bike rental for free. Milan is now implementing a pedal assisted bike sharing system, with around 1000 vehicles. It is the first example in the world of integrated bike sharing platform, with a fleet that is rather large. The subscription allows taking both standards bikes and pedal assisted electrical bikes.

'*Io guido*' the Sicilian platform for car sharing has the largest Electric vehicles fleet in Italy (24 vehicles) and allows with the same subscription to take cars in many cities in Italy and to take in Palermo, both standard cars, electric vehicles and pedal assisted electric bikes.

By means of GIS tools it is possible to measure the urban health in different areas (mobility, energy, social etc.) and to create functional maps for the design of strategic choices in the contemporary city. Since some years MIT and the SENSEable City Lab founded by Carlo Ratti [40] shows the big cities (such as Singapore and New York) in a different way and not as we have seen them till now.

Maps show people movements and habits and give information about people needs. The urban metabolism [41] is a mutating and undefined being, with contours and different faces.

Monitoring traffic congestion can also be accomplished using smart phones. GPS-enabled cell phones running the Google Maps application continuously pass along each user's location and speed to Google in real time. Using a technique known as "crowdsourcing," Google combines the information provided by thousands of active cell phones to determine how swiftly traffic is moving through a given location. Although this feature can be disabled on cell phones, Google has attempted to discourage users from doing so by making sure all the information it gathers is anonymous.

In the city of New York, the traffic congestion and other features are monitored by thousand of taxicab [42] by HubCab. The latter is an interactive visualization that invites to explore the ways in which over 170 million taxi trips connect the City of New York in a given year. This interface provides a unique insight into the inner

workings of the city from the previously invisible perspective of the taxi system with a never before seen granularity. This registration allows understanding the most common trips in cities (especially for large-medium size cities). These people moving with the cab are may make the same job and have same needs. For this reason, through these studies it is possible to put into evidence that the use of cabs could be rationalized and tariffs for individual citizens could be lowered (car pooling/sharing).

Another interesting platform concerning mobility in Italy is *Flightcar* [43]. It combined the comfort of peer-to-peer car sharing with the possibility of car rental. When going for a medium-long trip, the car can be left at the airport by the owner. Flightcar rents the car of the person that leaves to another person that arrives and needs a car for rent at the airport. The subscription to the platform is easy and requires a reliability proof that can be acquired through the ministry of transports.

All the service of rental and car release is managed by a very accurate customer care service. Most of the operations are managed on-line.

The person owing the car will be compensated economically and will not pay any fee for parking.

Besides the research tells us that sharing mobility is a profitable business because car use is changing and the first that must realize this are the car makers. People want to drive, but unlike the pre-crisis period they want to have cheaply the availability of the car that can easily be borrowed or rented to someone else without necessarily having to purchase it.

This generates a new type of demand and it is no coincidence that more and more car manufacturers, railway companies and airlines hi-tech companies are entering this market. Take for instance the car-sharing services such as Car2go Daimler AG and the Italian ENI and Fiat Enjoy by Trenitalia. The sharing mobility is one of the fastest growing areas in terms of users and revenues from sharing economy of a disruptive paradigm, fueled by the explosion of digital technologies, where access [44] takes over possession.

A recent study by Roland Berger Strategy Consultants has shown for the four most popular services (car sharing, ride sharing, bike sharing and Shared parking) annual growth rates between 20 and 35 % and revenue forecasts between 2 and 6 billion dollars for 2020.

All services of sharing mobility are based on the following principles:

- application of mobile solutions: software for mobile devices that enable the user to finalize the rental contract at anytime and anywhere;
- social Aspect: sharing of information among users through channels of evaluation that will produce positive or negative feedback and that constitute a kind of assurance on the reliability of the service offered;
- needs and services offerings that can be easily divided: action of suppliers and users in accordance with the logic of the market and of their interest in order to eliminate inefficiencies and waste rather than with acts of pure altruism.

Even in the field of smart energy have been recorded in recent years considerable changes, which often have as common thread, the size of the sharing of new experiences, to reach such a savings target. An example of this approach is the European ADDRESS project [45], focused on active demand in electricity grids of the future with the aim of making them more accessible, flexible as well as economic and reliable for consumers, providing them with the ability to change supplier, get incentives and participate in promotions, causing them to become an active part of a system. Loads household can be classified into three categories, which correspond to different control strategies: deferrable loads, such as washers and dryers; interruptible loads such as freezers and water heaters; thermal loads such as air conditioning and electric heating (green inset Fig. 7.3). However, the powers of individual consumers taken into consideration are limited. So also the amount of electricity that can be managed with flexibility by a single consumer is very limited, and would not be useful, or interesting for the efficiency of the electrical system, if it was not possible "to aggregate it" to that of a large number of consumers, in order to achieve a significant volume. For this purpose, it is needed an aggregation service, which ensures the coordinated action of many small consumers. The ADDRESS project was addressed to domestic consumers connected to the LV network with a maximum of 100 kW of installed power which could be made flexible in relation to time of use and the amount of power used.

The recent development of ICT, in particular of wireless type, paved the way to the aggregation of load. This new way of consuming provides for the possibility of entrusting to a third party (the aggregator) their consumption profiles. The aggregator acts as an intermediary between the energy market and consumers of electricity (the system interface are the Energy Box installed in households): he collects the demands of the market, buys wholesale power and sells it to consumers at competitive prices, trying to meet the demands from the market by exploiting and aggregating the consumption and generation of energy to its customers (area "Markets and Contract", Fig. 7.3) [45].

Exposing some flexibility in consumption, each consumer participates then to cover purchases of the same aggregator in the energy market. The ongoing revolution allows a cost reduction for end consumers and even a reduction of emissions by proper dimensioning of the infrastructure, from generation to transmission and distribution of electricity. In the presence of a peak load, rather than to oversize the infrastructure and production capacity, bringing the generation unit to work in regimes of low efficiency, loads are displaced in time of consumption and peaks can be controlled [46].

The spread of generation sources of renewable and non-programmable type makes the role of the aggregator even more significant to compensate through the flexibility of the load even peak generation.

In Europe, interest in the aggregate load is increasing, but in some countries it is already a reality: AV Reserveffekt AB in Sweden and Votalis [47] in France. In the US, the load aggregation and participation of electricity consumers to limit the construction of new infrastructure is well established. For several years, the energy planning of the states is carried out through the provision of a participation of the

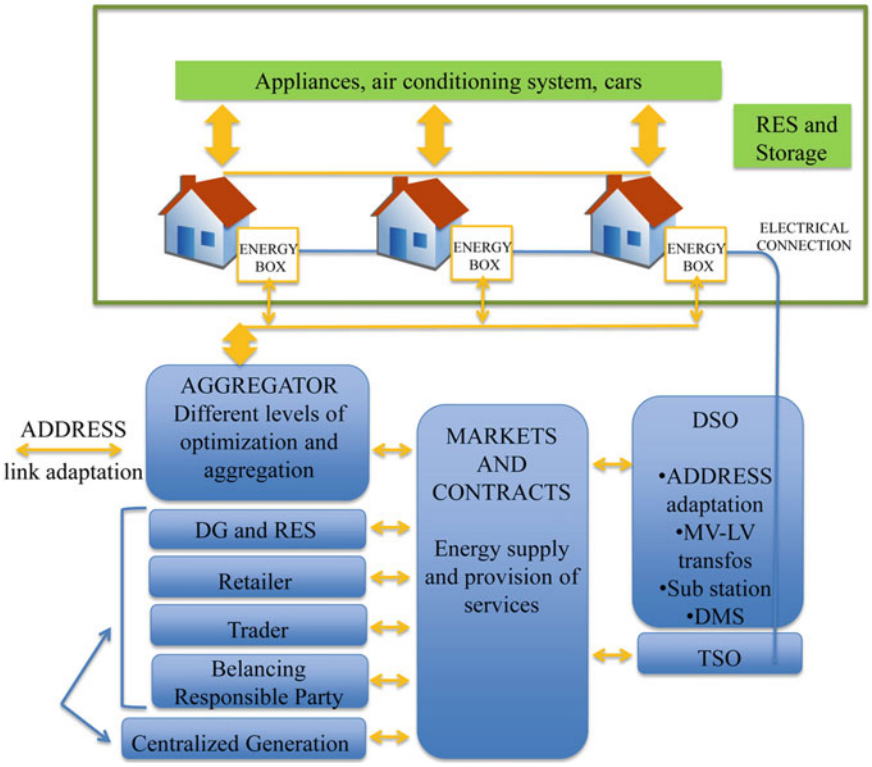

Fig. 7.3 ADDRESS project architecture

load not only to actions that affect the market, but also concerning the so-called ancillary services, i.e. services to support actions of adjustment to maintain quality electricity supplied by high standards.

Examples of sharing part of energy services [48] are the groups of energy purchasing, already active in different European contexts and that in Italy have started in 2013. The liberalization of the market energy has opened the possibility to create buying groups able to hold auctions addressed to the suppliers of energy (electricity or gas for domestic use) on the market and therefore to enter into a supply contract with whoever offers the best service according to the needs of members. The aim is to come together to negotiate the best price, because the group allows a contracted capacity that is not reachable by the individual company/family, with significant discounts and quality assurance of supply. The estimate of the association "Altroconsumo" in Italy (one of the largest consumers associations in Italy) is to have a saving of about 210 € a year per family.

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Chapter 8
The Role of Technology in Participative Processes

Eleonora Riva Sanseverino

Abstract Smart city is more and more, in the common feeling, the crossroad of technologies, but first and foremost, the place where humans, contexts and technologies meet and must interact. Technological systems thanks to the deep human interaction acquire an uncertain behaviour that can be hardly modelled and controlled. The resulting complexity, cannot be easily handled with the tools that are available to separate scientific fields. The interdisciplinarity that comes from the implementation of technologies and the dialogue between these and the territories requires new tools for classification and design. New urban design tools are needed allowing to identify in a standardized way adequate support measures for urban functions deployment (energy, mobility, water and waste management).

8.1 Introduction

As a consequence of the pervasivity and impact of smart cities infrastructures (technologies for production from renewables, recharging stations for EVs, supply of transceiver stations, cablings), it is urgent to have city plans integrating these elements and conceptual approaches with a suitable regulation for each territory. Also maintenance scheduling and a coordinated planning for these infrastructures will dramatically reduce the costs for urban administrations. In strongly historicised contexts a new and stronger attention is needed, as compared to the new expansion areas. In the latter case, there is more freedom to deploy interventions that are more compatible with existing buildings and the whole urban context. The case of Stockholm is an uncoded example of this way to act at urban level. It certainly represents a "best practice" that comes from years of experimentation, but it does not represent still the integrated planning model that is here proposed. All the

E. Riva Sanseverino (✉)
Dipartimento di Energia, Ingegneria dell'informazione e Modelli maematici (DEIM), University of Palermo, Palermo, Italy
e-mail: eleonora.rivasanseverino@unipa.it

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infrastructures in the new city are interconnected and influence each other making management and control of technological systems more and more complex. The way in which these infrastructures interact is a paradigm for understanding the new model of intelligent city. Understanding all these issues and taking consequent actions, as it is shown by the examples shown in the Atlas, brings to public administrations large savings and allows the development of innovative city models around new productive drivers. From the technological point of view, all technologies are 'on the shelf', therefore what is missing is knowing exactly how to combine and use them into the city. In this view, even the rigorous traditional separation of decisional levels and of technical roles in the administration of cities turns to be obsolete. It is thus necessary to look at the city transformation thinking that the city is the place where a new humanism of technology, after years of blind enthusiasm, is now facing the challenge of the presence of humans as main actors.

These being consumers and providers of products and services in the contemporaneous city. The strong interaction between infrastructures is evident if we look at electrical systems, these being the infrastructures that must support most of the urban functions. The entry of renewable power from strongly unpredictable sources has deeply modified the physical quantities involved and the modelling and operation of electrical systems. A close look at the load diagram provides an insight into this problem. Figure 8.1 shows the cumulated electrical load supported by distribution networks. It can be easily observed that in Italy the peak of the electrical load is shifted at the end of the day, while the first peak disappears as an effect of the strong contribution from photovoltaic power in the central hours of the day [1]. It is also interesting to observe how building automation and home systems, together with suitable Time of Use tariffs, influence the load diagram producing a strong change of the load consumption profile in residential buildings [2]. The peak flattens and the load diagram becomes more regular, such feature allowing the distributor to exploit the full capacity of electrical distribution infrastructures. The installation of local energy generation systems (both from renewables, biofuels or standard fuels) implies a substantial modification of the role of the consumer which becomes *prosumer* (producer and consumer). People are a further source of uncertainty in the unpredictable relation between them and the market, thus modifying the power flows in electrical power systems as a consequence of price signals coming from the market (Fig. 8.1).

Some interesting projects concern the possibility to increase the self-consciousness of users about consumptions. The electrical Italian DSO Enel during 2014 has supplied its customers (experimentally in some municipalities) a tool for active participation called kit *Smart Info*. The apparatus, inserted in any electric plug, stores the consumption data that are then collected at the main board of the house. These are made available on the pc, tablet and smartphone, providing in real time the actual and past levels of consumption. According to the results collected up to now, 90 % of interviewed customers considers that they have acquired a higher level of consciousness about consumptions and their distribution in the different hours of the day, while around 60 % of the users have declared that they have reduced their consumptions through energy efficiency measures.

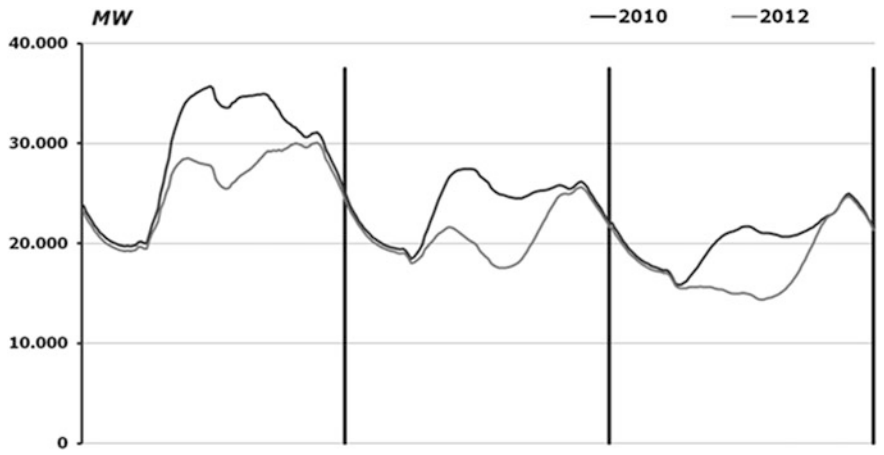


Fig. 8.1 Impact of distributed generation on the average load connected to MV substations in Italy

Another element of big interest is the use of electrical mobility in cities, for which it is required the installation of recharging stations. As a consequence of the penetration of EVs and hybrid cars[1] in the market, the electrical load diagram is expected to change rather strongly producing an effect that is difficult to predict and is strongly connected to life of people and mobility parameters, such as unemployment levels, presence of public mobility, habits,[2] etc.

Norway is recently heading towards electric mobility. The Norwegian government has imposed onerous taxes on the purchase of cars on the basis of the size of the engine, as well as of the fuel price, both of which buyers of EVs are exempt from. Causing tens of thousands of dollars of savings, right up front. Besides there are incentives of convenience, such as access to bus lanes, free parking, free ferry and toll bridge access, as well ample no-cost charging stations. This has compelled many people to launch fully-electric taxi services, and while there are already rumors about the fact that some of the incentives are going to be limited soon, most officials and taxpayers seem pleased with how well the plan has worked out till now.

Another basic infrastructure for smart communities is the Telecommunication, TLC, infrastructure, made up of sensors and actuators, that are remotely manageable through suitable protocols, and elaboration nodes that at various levels are able to collect signals and send commands, where necessary. These networks are characterized by means of architectures and languages that are different according to the purpose for which they are predisposed. The TLC infrastructure enables the interactions among the different actors of the smart city. The most common and

[1]Cars with and ICE and an electric motor.

[2]David Levinson, The End of Traffic and the Future of Transport, Kindle edition, 2015.

visible applications of TLC technology in smart cities are mobility congestion management systems, these aim at air pollution limitation in the urban microclimate. As an example, the project "Smart vehicular mobility and traffic management" implemented by the SmartcityLab[3] develops these issues. More recently the *Internet of Things*, IoT, technology is entering the market with a wide variety of offers and technologies for interoperability among apparatus. The strength of the IoT technology is that data collected massively from the environment can be used remotely. Interesting research issues concerning this topic are, as an example, the energy saving for supplying mobile devices and sensors and the distribution of data analysis tasks among different apparatus. IoT is a new paradigm in which the virtual world of information technology and communication is strongly related to the real world. All this is now possible because unified languages (protocols) exist and they create connections between sensors, actuators and data elaboration systems. In this way, it is possible to create multi-function applications namely sharing the same communication infrastructure to deploy differen actions. In the IoT section, some applications dedicated to Smart cities are described.

Heat distribution through district heating or its integrated management at the users premises is also a critical infrastructure for cities. Heat and cooling demand is indeed strongly affecting environmental issues. In large buildings, building automation systems can already rule the operational set-points[4] of temperature regulation systems for each room, as an example, based on the cost of the electrical/thermal energy or based on maximum comfort.

Finally the waste management. The latter is certainly one of the major lost battles in many countries as well as in Italy. Many countries consider waste as an important development factor, through a production chain that allows the recycling of most raw materials. At the basis of the latter process and of all the above described processes, there is the sharing of common objectives and the participation of citizens.

In the following sections, some of the technologies for the implementation of a smart city are briefly recalled, ranging from renewables to the internet of things technology.

8.2 Technologies for the Production of Electrical Energy and Heat from Solar Source

It is well known that solar energy can be transformed into electrical energy or heat using the photovoltaic, thermal photovoltaic or thermal solar conversion.

Photovoltaic panels for the generation of electrical energy are systems whose producibility varies as a function of the incident solar radiation at the installation

[3] http://smartcity.csr.unibo.it/research/projects/, 2012.

[4] Desired temperature value.

site; of the orientation and inclination of the modules surface; of the presence of shadings or dirt and of the technical performances of the plant components (modules, energy conversion system).

In photovoltaic plants [3], the production of electrical energy takes place in the photovoltaic cell, elementary unit of the system, where the direct conversion of the solar radiation in electrical energy takes place, exploiting the capacity of some materials (suitably treated semiconductors) to generate electricity based on the photoelectric effect when exposed to solar radiation.

The photovoltaic systems can be connected to the electrical grid or can work in islanded configuration. The first, so called "grid-connected" systems, are steadily connected to the main grid. In this case, in the hours in which the photovoltaic generator is not able to produce the required energy, the grid can compensate. Vice versa, if the photovoltaic system produces an excess of electrical energy as compared to the load it supplies, the exceeding part can be transferred to the main grid or stored in batteries. The presence of storage units becomes necessary in stand-alone installations to meet the needs of the supplied customers, since the solar daily cycle and the weather perturbations no not allow a constant production.

Else than for domestic use, in cities, the most common stand-by applications are needed to supply:

- wireless repeaters, data transceiver stations, telephone systems;
- refrigerators, especially for medical use;
- lighting systems;
- street, ports and airports signals;
- advertisement boards, etc.

The use of photovoltaic panels is today simpler due to the possibility to create building elements that integrate such technology using "thin film" photovoltaic layers (employing amorphous silicon). These layers are created by means of deposit of semiconductor material on a supporting layer. Panels can indeed be integrated into the buildings and can replace: finishing plasters; coverage structures; stained glass; sunblind; skylights and tiles. In this way, it will not be necessary to create additional room, but the existing volume is used and additional supporting structures are not required. These photovoltaic generation is also called *unconventional* photovoltaic generation. In this way, the roofs of the sheds can be covered with an 'easy to install' flexible sheath that outputs energy but also holds insulating properties; semi-transparent modules with limited impact can be applied in archaeological interest sites, making them autonomous from the energetic point of view; glasses that can turn incident light into electricity [4]. As already briefly shown, the types of photovoltaic panels that are available on the market are substantially different one from the other, due to the supplementary function they can take but mainly due to the type of silicon used to implement the cells and thus the producibility of the plant. The crystalline silica (monocrystalline and polycrystalline) cells show higher production potential, under same incident solar irradiation, but do not allow to implement flexible elements, due to the same constitutive

matter of silica; amorphous silica instead, allow the implementation of *thin film* layers, that show limited producibility and at the same time limited visual impact since they can be easily integrated into architectural elements. This is the reason why, as it happens most times for technical choices, the designer must assess and weight producibility, installation cost, mode of connection to the grid, visual integration, etc. A recent study [5] shows a dramatically increasing trend of market penetration for BIPV technology (building integrated photovoltaic technology).

On the basis of the function, the materials employed and relevant mechanical features, BIPV products, can be classified into five categories:

1. Standard in-roof systems
2. Semi-transparent systems
3. Cladding systems
4. Solar tiles and shingles
5. Flexible laminates.

All the cited products, except the last category, involve same type of technologies namely crystalline silicon and thin film technology. The flexible laminates can only be implemented by means of thin film technology. Under all the above classes, different types of photovoltaic applications can be integrated into different parts of the building systems, namely: roof, external building walls, semi-transparent facades, skylights and shading systems. Typically, flat and pitched roofs are ideal for the integration of photovoltaic generators. Roofs indeed in most cases provide a large, not used surface for photovoltaic integration. A more elegant mode for integrating photovoltaic technology is to use solar shingles or tiles. In this case, the photovoltaic module is installed as any shingle or tile.

More recently, the so called third generation photovoltaic cells show large applicability for BIPV installations. Called in this way as an alternative to the first generation photovoltaics (crystalline silica c-Si) and the second generation cells (thin film technologies), the third generation technology are designed to combine the advantages of both the first and second generation devices using the so called multi-junction cells [6]. They promise to provide high efficiencies and reduced costs as compared to the first two. Third generation approach include:

– photoelectrochemical cells;
– nanocrystal solar cells;
– dye-sensitized solar cells;
– polymer solar cells;
– tandem cells.

Among these, the dye-sensitized solar cells or DSC offer at present conversion efficiencies that seems to be high. Due to their interesting features they seem to have immediate commercial applicability and limited production costs and easy deployable manufacturing technology. Their efficiency, the maximum in the category of plastic based organic cells varies between 9 and 12 % in relation with the cell colouring [7]. The working principle of DSC, also called Grätzel cells from

their inventor Michael Grätzel, professor of chemistry and director of the laboratory of Photonics and Interfaces of Ecole Polytechnique Fédérale de Lausanne, is similar to that of vegetables photosynthesis. The chlorophyll in the leaves absorbs the sunlight and transforms the gaseous carbon dioxide and water in glucose and oxygen. In this way, the solar energy is converted in chemical energy. In a Grätzel cell an analogous artificial photosynthesis process takes place, in this case a colouring matter (chromosphere), namely an organic or hybrid molecular (organic-metallic) taking the role of chlorophyll, absorbs the photons turning the sunlight into electrical energy. The use of DSC cells for BIPV is therefore a realistic perspective due to the transparency of modules and the low production cost.

Some studies however outline the variation of transmittance changing the heat loads into the buildings due to extensive use of DSC technologies as BIPV [8].

The use of photovoltaic cells is also at the basis of thermal-photovoltaic systems (TPV) [9]. These turn in electrical energy the energy irradiated by a surface, the so called emitter, at emission temperature (mainly in the infrared spectrum). The working principle of the electrical part is thus the same of that of the solar photovoltaic cells, but with basic differences in the wavelength of the electromagnetic energy received by the cells and in the required working temperatures.

The TPV technology is well suited for residential applications, Fig. 8.2, namely applications in which the solar energy is transformed both into electrical energy and into heat that can be used for heating purposes. The absence of moving parts, except than for auxiliary components, the ease in maintenance and of the working principle, allow to keep low the noise pollution. This technology is indeed quite indicated for areas that must be particularly safe from the environmental point of view and in residential areas and can easily substitute the conventional heaters. There is also the possibility to integrate this technology, in the pre-heating phase, with conventional heating systems supplied with standard natural gas or other fuels, thus reducing CO_2 emissions.

The direct conversion of solar energy into thermal energy can be carried out through solar collectors (solar panels) and is at the basis of the 'solar thermal' technologies (Fig. 8.2).

The low temperature technologies include the systems that use a solar collector (solar panel) to heat a liquid or the air, generally below 100 °C, for the production of hot sanitary water and for rooms heating (in particular cases, this heat can be used for essication, sterilization, desalination).

The high temperature technologies are instead mainly used for the production of electricity: the hot fluid that is attained thanks to parabolic linear mirrors, solar towers, independent parabolic concentrators, is used to make a steam turbine move (solar thermodynamic). Figure 8.3 shows a solar thermal plant with forced circulation that could integrate the operation of an auxiliary system (heater) for the production of hot sanitary water in a house. Differently from what it happens for photovoltaic panels, for solar thermal panels the inclination is not so important. As it can be easily understood, based on the needs and on the installation features (availability of large or small areas, shadings from fixed objects, etc.) the designer may choose one or another solution.

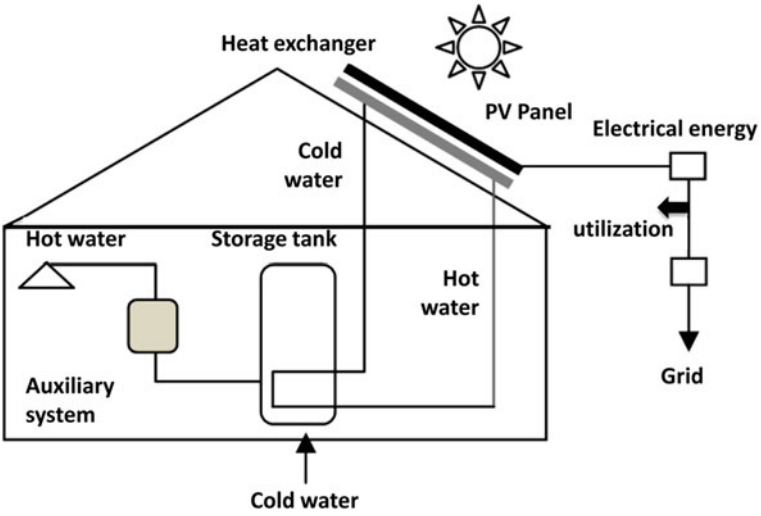
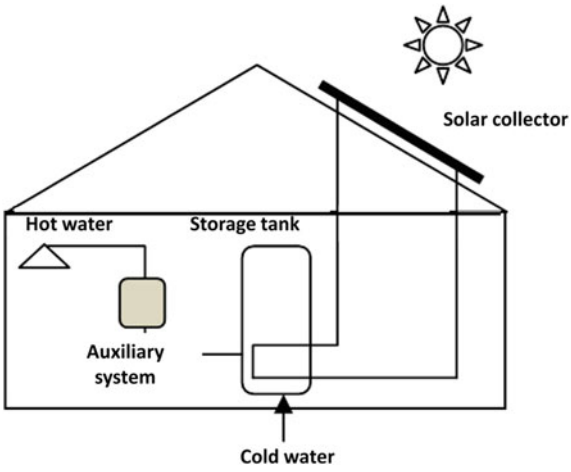


Fig. 8.2 Electrical and thermal energy production from thermo-photovoltaic

Fig. 8.3 Thermal energy production in a solar thermal plant with forced circulation



8.3 Cogeneration and Micro-cogeneration

As already said, cogeneration is a term used to say 'combined production of electrical energy and thermal energy'. In a conventional thermal electrical installation, for the generation of electrical energy, the chemical energy of the fuel, then transformed into heat through combustion, is employed in a electro-mechanical process that turns it into electrical energy. The thermal energy is a by-product of the process of electrical energy generation and is generally lost, giving rise to efficiencies that range between 40 and 50 %.

With a co-generation system, the thermal energy is instead conveyed to be then recovered and employed for heating. In this way, an efficiency that goes beyond 85 %, with a consequent earning in economic and environmental terms, is attained. The residential context in Euro-Mediterranean areas is characterized in many cases by small heaters for the production of hot sanitary water, therefore, unless the system is centralized at condominium level, the thermal load is generally small, compared tp the electrical energy that can be requested by homes (3 kW of electrical power and around 2700 kWh of yearly consumption of electrical energy). Micro-cogeneration, whose installed capacity is, according to the Italian ruling system (definition of GSE, the Italian management entity of the energy system), below (dlgs 20/2007) 50 kWe, is now becoming an interesting solution in residential units. Cogeneration units with rated power between 50 kW and 1 MW are instead referred to as mini-cogenerators. More in general, the types of plants can be distinguished based on the type of prime mover employed.

The most employed prime movers are of three types: gas turbines; steam turbines; combined cycle turbines (gas/steam).

The latter two types of generators typically show high rated power and are used for industrial applications, while the internal combustion engines and the gas turbines find application also for mini and micro-cogeneration plants. Together with these 'traditional' technologies it is worth mentioning the modern turbogenerators ORC, the microturbines, as well as the so called 'innovative technologies'—the most advanced solutions in the field of cogeneration—that include: the fuel cells, the Stirling motors plants and the already mentioned thermal photovoltaic plants. The internal combustion engines for cogeneration have rated powers between 20 and 100 kW. They have a fundamental role in a set of stationary applications such as emergency rotating generation. In these machines, the prime mover is a traction motor that works at fixed speed (the speed being a function of the required frequency and of the type of synchronous generator).

Also in this case, the fuel is natural gas but there are also examples of motors that are supplied by bio-gas and bio-fuels. The small motors for cogeneration show limited electrical efficiencies, ranging between 20 and 30 % and they turn to be competitive only in presence of thermal recovery executed for a large part of the year. On the other hand, the small motors are characterized by a high operation flexibility, being able to work at partial loading without an excessive decay of performance. Using the gas microturbines technology, the electrical energy production takes place during the phase of expansion of the combustion gas that occurs into the turbine (the mechanical work is then turned into electrical energy with a generator that is connected to the turbine axis) while the heat recovery comes from the combustion gases outputted into the environment (reaching temperatures beyond 450 °C).

They have rated electrical power between 30 and 200 kW.

The employed fuel is natural gas, but some producers use turbines that are supplied with biogas. The advantages are connected to the life cycle, reduced maintenance and limited noise while electrical efficiencies are relatively low and

require the use of fine fuels (gas, light oils) to prevent phenomena of dirt and corrosion of the turbine's blades.

The organic Rankin cycle (ORC) generators are similar to the steam turbines. Instead of steam they employ an organic fluid that is vaporized using the heat coming from a heater or from solar collectors. After having passed through the turbine, the organic fluid gives heat for thermal uses (industrial processes, remote heating, etc.) and, once it is cooled down, the heat goes back to the evaporator, giving rise to a closed thermodynamic cycle. Thanks to the high electrical (18 %) and thermal (80 %) efficiencies, they are ideal machines to produce heat and electricity in medium small sized plants (mini-cogeneration) supplied through biomass. These are plants characterized by the necessity of limited maintenance and by a long lifetime, but they are cumbersome and are sized above 200 kW. They are not adequate for the employ in the very small cogeneration (micro-cogeneration).

The so called *fuel cells* are apparatus that comprise many individual cells that are grouped together to form a fuel cell stack. Such as normal batteries, they produce electricity not just by means of thermal combustion, but by means of an electrochemical reaction starting from reacting substances: in this case, typically hydrogen, the fuel in which the energy is stored (it can be produced by means of electrolysis or derived from natural gas or renewable biogas through a reforming process) and the oxygen that is contained in the air, that acts as oxidising matter. The efficiency of a fuel cell is very high. The electrical generation is highly silent and the system is extremely compact. The electricity generation does not produce emissions and for this reason they are well suited for mini and micro-cogeneration. Fuel cells cleanly and efficiently convert chemical energy from hydrogen-rich fuels into electrical power and usable high quality heat in an electrochemical process that is virtually absent of pollutants. The fuel cell stack is supplied by fuel, in the stack, the methane (CH_4) from the fuel is reformed and the hydrogen (H_2) is generated with carbon dioxide (CO_2). The resulting electrochemical reactions in the fuel cell anode and cathode produce direct current (DC) power, which is then converted to alternating current (AC) power. Other produced energy carriers is heat that can be used to customers for facility heating and cooling or for making steam. Because there is no combusting of fuel, virtually no harmful emissions are generated by the fuel cells. This results in power generation process that is almost entirely absent of nitrogen oxide (NO_x), sulfur dioxide (SO_x) or particulate matter. The Stirling motor is an internal combustion engine, even though the combustion process takes place out of the cylinders where the pistons slide. The heat is provided from the outside through a heat exchanger. This motor is characterized by a silent operation and requires limited maintenance, it has a high thermal and electrical efficiency (reaching 90 %) and a high cost. Moreover, since the motor is quite cumbersome it usually has rated power below 100 kW (mini and micro-cogeneration). The integration between the Stirling motor and the gasification process allows to employ biomass (i.e. wood chips) as fuel for energy production. The use of biomass allows to set to zero the CO_2 emissions. This motor with the above described features is certainly a technology that is useful to limit the polluting emissions according to the limits set at international level.

8.4 District Heating/Cooling and Urban Heating/Cooling Systems

The District Heating/Cooling, DH or DC (also called remote heating or remote cooling), is a system for the distribution of heat/cool generated in a centralized site to meet the heating/cooling demand for residential and tertiary use. The heat is used to produce steam or hot water or cold water. The components of a District Heating/Cooling system thus are the heat/cool production plants, the distribution network and the exchangers. The heat is often obtained through cogeneration systems supplied by fossil fuels or biomass, geothermal energy, solar or nuclear energy. If a cogenerator system for the heat production in the DH is used, in relation to the higher efficiency of the thermal machines, this infrastructure produces less polluting emissions as compared to the solution of heat generation by smaller sized systems. Moreover, differently from the domestic cogeneration or for single building supply, the electrical energy produced is injected into the public distribution grid. Some studies [10] underline that the cogeneration technology together with the DH system (CHPDH, combined heat and power district heating) is the less costly method to reduce emissions of carbon dioxide. Many European countries, in particular in northern Europe, use this system for heating the buildings in cities already since many years producing a significant reduction of polluting emissions. In Copenaghen, for example, the first DH infrastructures were implemented in the middle twenties. In this case the field that is commonly adopted for heating at urban level is also derived from waste. The heat distribution network in the city of Copenaghen (Copenaghen District Heating System, Global District Energy Climate Awards 2009) is part of one of the largest DH networks in the world. The heat transfer fluid is water in most cases and only in certain areas is steam. For the cooling instead, to supply the chiller (whose working principle is that of conventional heat pumps), electrical energy, natural gas or solid urban waste can be used, the heat transfer fluid can be water from lakes, sea or also purified waste water. An example in Europe is in the city of Barcelona in Spain, where a DC network, since 2002, is constantly expanding. In this case, a large plant degassing in the port of Barcelona and the depressurization process of the liquid natural gas, delivered at a temperature of −165 °C, is used to reduce the seawater temperature that serves as the heat transfer fluid for the DC system [11]. When the construction of a District Heating network shows difficulties, it is interesting the use of innovative available heat sources in urban areas. The centralized heating system of Kungbrohuset building near Stockholm Central Station is one example. In the central station, the body heat is collected from the air vents of the ventilation system and is transferred to pipes in which water flows in heat exchangers. The water is then fed into the flow pipe of the building heating system. This system produces a reduction of 25 % of the costs for heating.

In this frame, low temperature DH, LTDH, shows interesting perspectives. LTDH is defined as a system of district heat supply network and its elements, consumer connections and in-house installations, which can operate in the range

between 50–55 to 60–70 °C supply and 25–30 to 40 °C return temperatures and meet consumer demands for thermal indoor comfort and domestic hot water. If temperature of circulating water is reduced, the energy performance requirements of new and renovated buildings set progressively lower limits on energy consumption for heating, and thus, energy efficiency on the consumer side increases considerably. Better energy performance of buildings makes low temperature district heating supply possible. More important, DH supply losses can be reduced considerably when reducing network temperatures. This increases supply side efficiency and competitiveness of DH systems to supply also low energy buildings in low energy density areas. Another important benefit from LTDH is increased utilisation efficiency of renewable energy and low temperature resources [12]:

- Low temperature renewable energy resources. District heating supply temperature below 60 °C makes geothermal plants more advantageous to satisfy the base load heat demand; similarly, it increases the efficiency of solar thermal collectors, both in case of roof applications and largescale solar thermal field.
- Heat pumps. Regardless of heat source, efficiency of (electric) heat pumps is higher the lower the required district heating supply temperature is. LTDH supply temperature opens up for a broader range of heat pump technologies.
- Surplus heat. Utilisation of excess heat from industrial processes or by heat recovery from cooling processes is better and cheaper the lower the required district heating supply temperature is.
- Flue gas condensation.[5] The water return temperature in LTDH systems increases the possibility for flue gas condensation. This is particularly relevant for biomass/waste plants due to the high moisture content in the fuel.

8.5 Small Wind and Micro Wind Generators

The term *Small wind generator* means a wind farm whose production varies between 1 and 20 kW. The term *Micro wind generator* instead usually refers to small installations to below 1 kW. The difference with the larger wind power generators lies not only in the size of the machines, the ability to produce energy with lower wind regimes and, for this reason, the small and micro wind generators are adaptable to any site, which is sufficiently windy to justify the investment. Similarly to photovoltaic systems, types of installation of a small and micro wind generator can be networked or non-networked.

[5]Flue gas condensation is a process, where flue gas is cooled below its water dew point and the heat released by the resulting condensation of water is recovered as low temperature heat. Cooling of the flue gas can be performed either directly with a heat exchanger or indirectly via a condensing scrubber. The condensation of water releases more than 2 gigajoules (560 kWh) per ton of condensed water, which can be recovered in the cooler for e.g. district heating purposes.

Such as for any type of renewable energy source, the so called "stand-alone" installation is the one whose electrical output is accumulated by means of batteries and reused at any time. This technology is largely used where the power line is not present or is subject to frequent power failures such as mountain huts or isolated dwellings. On the other hand, the so called "on-grid" or "grid-connected" installations are generators for which the energy produced is fed entirely or partly in the national electric power line by selling it to the manager of electrical services.

Wind farms can be with horizontal or vertical axis. The wind generators of the first type are provided with the tiller for the wind alignment, the second type shows vertical blades placed around a rotation axis. The latter, for the same nominal power, have a higher weight and are less noisy. For the maximization of the performance they are mounted at a given height above the floor, on poles which, for the characteristic sizes of the small wind plants, fall below 35 m, for the micro wind they arrive at most to heights of 10 m.

The stakes must be lashed with appropriate foundation work. Still, it is possible to install the wind generators on lower height supports above existing buildings. In this case, it must be assessed whether the position allows or prevents the proper operation of the machine, or if there are obstacles that could compromise the performance.

8.6 Geothermal Energy

The use of geothermal energy systems can be classified in "low enthalpy" systems (essentially for direct use) that take advantage of the natural heat of the soil with the aid of a heat pump which can produce heat energy for hot water and heating of buildings, and "high enthalpy" systems (suitable for the generation of electricity), which are those that use the fluid contained in a geothermal reservoir (which can be "dominant water" or "dominant steam", based on the water content and vapor contained in it) for the production of electrical energy via the mechanical parts that compose the geothermal power plant (turbine, alternator, transformer).

The low enthalpy geothermal systems exploits the difference in temperature between the outer layers of the earth's crust and the external environment. During the winter season the ground is at a higher than the outside temperature; during the winter the heat is subtracted from the ground and is used for domestic purposes and vice versa with the cold in summer. These systems, unlike traditional geothermal, are not limited in the use in specific territorial contexts. They are based on two main technologies: geothermal probes and vertical heat exchangers (tubes) with depths ranging from 50 to over 200 m, and the serpentine system, comprising heat exchangers placed horizontally at 1–2 m of depth in loose soils.

Recent studies reveal that the geothermal potential in the cities is increased (the so-called "urban heat island effect") both by global warming as well as by human activities [13]. For this reason, in some cities where it is easily possible to realize

excavations, given the scarcity of archaeological remains, the superheated ground water can be used as a heat source for heating of buildings. The same studies reveal that cities with a longer history of urbanization behind, usually show this warming effect at greater depths.

In Europe, examples of the use of geothermal technology are present in several countries for use related to District Heating/Cooling (in the Italian city of Ferrara, Larderello and Castelnuovo). Normally, volcanic territories have a huge geothermal potential. In general, to extract and use the heat trapped in the earth, it is necessary to identify the areas with positive thermal anomaly where the earth's heat is concentrated: the tank or geothermal reservoir. Therefore, in areas where there are abundant geothermal resources in the subsoil, the installation of plants based on these technologies could meet both electrical and thermal energy needs.

8.7 Technologies for Sustainable Mobility in Cities

Sustainable mobility in cities is the result of several factors. On the one hand, encouraging citizens to move on foot, by bicycle or use of less polluting means of transport on the other strengthening and improving the efficiency of integrated urban transport services. Among less polluting means of transportation, the Electric-powered Vehicles, EVs, are those to which more attention has been paid. Less pollution is achieved both in the urban microclimate as well as in general, due to the energy generation mix supplying the countries, which is moving everywhere in the world towards reduced emissions and renewable sources.

The interest for this form of urban transport also arises from the possibility of achieving a virtuous interaction with the electrical power distribution system. Electric vehicles are equipped with an electric motor which during its operation is powered by a battery set. These batteries must thus be periodically loaded using the electricity distribution network. During the hours in which they are connected to the network, the batteries can then be used to provide regulation services (e.g. voltage regulation) through the use of the energy stored in them: it is the V2G technology, Vehicle to Grid, whose potential since some years is studied. The control system of generation and electrical loads must then interface with the infrastructure that provides for the charging of electric vehicles.

There exist many types of electric propulsion systems for vehicles. From low-speed neighborhood electric vehicles (NEVs) to long range highway-capable all-electric cars (BAttery Electric Vehicles, BEVs). Plug-in electric vehicle, PEV, is a general term used for electric vehicles that can be recharged by means of a plug, while plug-in hybrid electric vehicles, PHEVs refer to plug-in hybrids where an Internal Combustion engine is coupled with an electric motor that can be externally recharged (i.e.: Toyota Prius or Chevrolet Volt). Hybrid electric vehicles (HEVs) cannot be plugged and recharged from an off-vehicle electric energy source, therefore in this context they are not considered as purely electric vehicles.

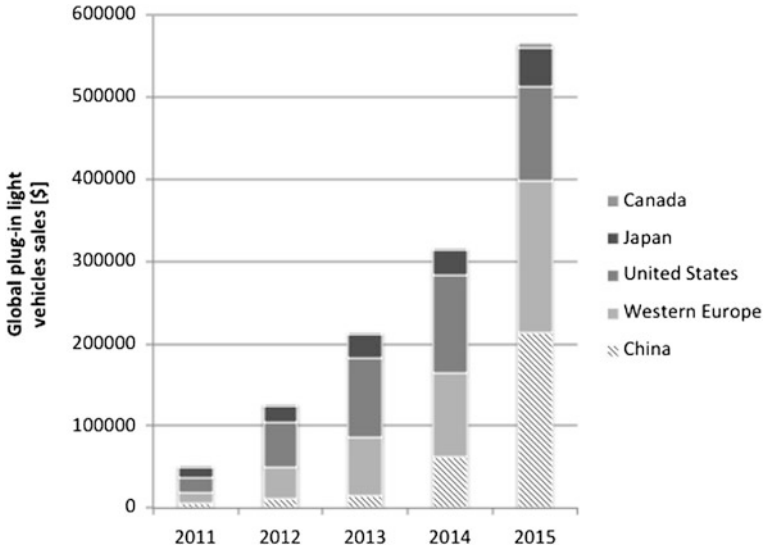


Fig. 8.4 Global annual sales of plug-in light-duty electric vehicles. *Source* Department of Energy, USA, 2015

Besides, the monitoring systems of the distribution system, in relation to the electrical loads and to their positioning in the distribution network, may suggest to perform the recharging at one EVs charging station or at another.

In Italy, the authority for electricity gas and water system (the authority) has granted assistance for the construction of five pilot projects for the installation of public charging stations for EVs. In other countries, incentives for purchasing EVs have created a market that is now well established (i.e.: Canada or Norway in Europe).

Figure 8.4 shows the global annual sales of plug-in light-duty electric vehicles.[6] China and Western Europe seem to be leading the growth of sales. That depends a lot on the incentives scheme. As an example, in China, the government calls the plug-in electric vehicles NEVs, namely new energy vehicles (NEVs), as currently only PEVs (hybrid or not) are subject to purchase incentives. China since 2010 incentivizes the private purchase of NEVs. In parallel, also the production capacity goals were increased to reach in 2011 a potential production of NEVs of 500,000 units. Also mass transportation based on electric power propulsion in China has been incentivized. The subsidies are part of the government's efforts to address China's problematic air pollution.[7] More recently, April 2016, the Traffic

[6]Argonne National Laboratory, United States Department of Energy 2016-03-28th. "Fact #918: - Global Plug-in Light Vehicles Sales Increased By About 80 % in 2015". Office of Energy Efficiency and Renewable Energy.

[7]"China announces new electric car subsidy program". China Economic Review. 2013-09-18.

Management Bureau under the Ministry of Public Security announced the introduction of new green license to create preferences among vehicles. NEVs for example in the city of Beijing are not subject to a driving restriction regulation that bans from entering the city for 1 day a week.

The system of incentives is also very strong and effective in Norway, where the Parliament set the goal to reach 50,000 zero emission vehicles by 2018. PEVs are exempt from all una tantum vehicle fees, including purchase taxes, which are quite high for ordinary cars, and VAT on purchase (25 %). Both measures make EVs purchase price quite competitive in Norway. Moreover, PEVs are also exempt from the annual road tax, all public parking fees, and toll payments (including domestic ferries), as well as being able to use bus lanes. All these incentives were set to be in effect until the end of 2017 or until the target of 50,000 all-EVs registered in the country was reached. In the country, sales of plug-in hybrids have had a smaller market penetration than pure EVs sales because they are not eligible for the same tax exemptions and other government incentives enacted for electric cars. In May 2015 the Government decided to keep the existing incentives through 2017, and the political parties in Parliament agreed to reduced and phase out some of the incentives. The system of incentives set up by Norway is certainly one of the most interesting in the world and probably one of the most effective, since one fifth of new registered cars in 2015 is a PEV.[8]

The new National Transport Plan 2018–2029 (NTP) sets the goal that all new cars, buses and light commercial vehicles in 2025 should be Zero Emission Vehicles, ZEV, namely, PEV or hydrogen vehicles. By 2030, heavy-duty vans, 75 % of new long-distance buses, and 50 % of new trucks must be ZEVs as well.

In 2014 (with 2 years of delay) in Italy, following the 2020 Strategy—the 2015 Transport strategy and the 2009/33/CE16 directive, the Ministry of transports has enacted the "Infrastructure national plan for charging vehicles powered by electricity", PNIRE. Every year, before June 30th, the plan must be updated and it must define the reference points to support the development on the national territory of an efficient EVs recharging network. Two main phases are considered in the plan. The first one (2013–2016) has the following objectives:

1. the introduction of a minimum size of electric vehicles;
2. the introduction of a basic infrastructure for public and private recharging stations;
3. the definition of technological standards;
4. the definition, development and implementation of policies to support electric mobility;
5. incentives to technological development.

[8]"Norway Is a Model for Encouraging Electric Car Sales" by David Jolly, Oct 2015, The New York Times.

The second consolidation phase (2017–2020) has the following objectives:

1. enacting common norms in EU;
2. the widespread of EVs on a larger scale (pure and Plug In hybrid);
3. the completion and consolidation of the public and private recharging infrastructure;
4. incentives to technological development.

For financing the plan, the Ministry has provided 15 million euros for 2015.

Finally, for what concerns the shared mobility systems, it must be underlined that their efficiency is strongly connected to the investments and the capacity to manage them by privates or local public administrations, or finally by public-private partnerships. Recently in Grenoble, an EV based car sharing service has been activated. The project involves a combined use of personal and public transport, a service called "Cité Lib by Ha:mo" that's been ongoing in Grenoble for the second year and a half.

This was possible thanks to the interconnection between ultra-compact EVs and public transports, else than the availability of recharging stations. The proposal unifies the competences of 5 partners, among which EDF and the subsidiary Sodetrel, the groups Toyota and Cité Lib, a local car sharing company Car Sharing. The basic part of the project are 70 ultra-compact EVs, the three-wheeled Toyota i-ROAD and four-wheeled COMS, available on a sharing platform called Ha:mo (harmonious mobility). The vehicles are located on 27 charging stations, for those people who arrive to the urban area via public transport after being picked up from a suburban area, where their personal vehicles—that took them there from home—are parked. People can use them either in a round-trip or one-way pattern, and they can be booked using the private smart phone. Citizens can also plan their multimodal trips in the city by connecting to Métromobilité, the route planning service of Grenoble. The project is scheduled to take place over 3 years until September 2017 and has proven to be quite successful with over 1000 registered users and a 92 % satisfaction rate.

8.8 Technologies for Human–Machine Interactions in Cities

Communication between individuals and the transfer of experiences and knowledge between them is the basis of any sharing experience and shared goals. The technologies mentioned above only constitute one piece of a complex mosaic that allows a community and the complex system around it to define a "smart community". Since many years it is possible, through the electronic transmission of data, the remote control of devices that operate on technical systems or that provide or process information collected at the same systems.

In domestic contexts and in services, home automation and building automation enable the automation of all the technical installations of a house through the "bus" technology. The buildings of a city are already parts of the city districts seen as multi-carrier energy hubs in cities (electricity, heat, mobility, management and disposal of waste and data transmission services) and automation of technical installations in them is only the peripheral part of what will be the automation and telecommunications infrastructure in the smart city.

The technologies are already widely available and the choice depends on the type and amount of data that must travel and the required speed according to the performance and reliability targets of the transmission.

The Internet network finally put in communication the individuals between themselves and with the technological systems of the housing if desired.

8.9 Polyfunctional Infrastructures

More recently, the need to allow interactions between the technological infrastructure and services in cities and territories and at the same time the industrial urgency to conquer new markets has prompted some producers of components for the electrical systems realization of intelligent infrastructures. The latter are equipped with systems for the processing of information also for transmitting them.

Such as in other cases, the research and development of new solutions in the electric field anticipates future trends. Just as it occurred in the case of "smart grids" that anticipated the concept of "smartness", even in the smart city infrastructures that are born to perform a single function possibly dedicated to a single actor, they may be shared among various actors.

This is the case of traffic lights that broadcast traffic information and able to change the timing of the green and red lights to make sure that automobiles are always in motion. The system receives data from the roads using for tracking radar systems and video traffic units, or electromagnetic coils embedded in the asphalt to hear the amount of traffic that moves on the roads and pass on information about the number of cars that have stopped to red or that are passed with the green and at what speed.

The same monitoring systems allow the control of the territory, the identification of the plates numbers both in order to fine anyone who has misbehavior or to identify the criminals cars.

Light sensors positioned on the poles of public lighting can control and dim the LED lamps installed on the same smart poles. These poles are often infrastructures supporting solar panels that feed energy into the network during the day, dropping to zero the overall energy balance of the public lighting system if suitably coupled with storage units. These infrastructures as well as the means for the shared mobility in cities could also become hotspots for a mobile Wi-Fi network. This is the bet of the Veniam startup based in California, USA, that has just made it a fully functional and marketable technology. The inventors also believe that this

technology will be a driving force in the development of the Internet of Things technologies (see next paragraph).

In the case of electrical systems, very recent technological solutions produced by Prysmian[9] provide for installation on board of electrical power cables of 'intelligent' components able to sense in wireless mode the electrical quantities to prevent possible disruptions on the power distribution network electricity by early diagnosys. The same items can be used, in the near future, to prevent fraud and to perform a monitoring stringent environmental quantities or relating to technological system in which they are installed.

Other solutions for water management systems as 'Watermole' produced in the iXLEM Labs (in collaboration with the Qatar University, Qatar National Research Fund, the Monferrato aqueduct, Smat and Karamaa) allow the problems of management and monitoring solution in systems of urban water distribution. Mobile wireless sensor can be placed in pipes (smart pipes). The multifunctional smart pipes integrate sensors able to sense mechanical stresses, temperature and anomalies in terms of pressure, so as to measure the water flow rate and water quality during the service. The connection of the smart pipes with a processor with the ability to communicate wireless and enables the direct transfer of data to a control center, in this way the distributor is able to identify losses and other problems related to the distribution (iXYLEM 2011).[10]

Among the polyfunctional infrastructures is finally to cite the case of the coatings of the new generation buildings capable of generating electricity through recent technologies (such as the translucent DSC cells used for the construction of glass block panels[11]).

8.10 Internet of Things for Smart Cities

Among the multifunctional infrastructures, the internet of things technology has an important place. A definition of IoT is offered by the Strategic Research Agenda of the Cluster of European Research Projects on the Internet of Things (CERP—IoT 2009): is a global network infrastructure, dynamic and with self-configuration capabilities based on standard communication protocols and interoperable, where the physical and virtual objects have an identity, physical attributes, virtual personalities and use intelligent interfaces, as well as being perfectly integrated into the telematics network. In simple words, any sensitive subject to external conditions (sensor) and any object that can act on the reality (actuator) is interconnected and electronically accessible. Interoperability is thus at the base of the IoT technology

[9] https://pry-cam.com/en/.

[10] http://www.ixem.polito.it/projects/qnrf_2009/index_e.htm.

[11] http://www.SBskin.com.

that according the Gartner hypercycle[12] is at the apex of expectations for 2015. As compared to 2014, major changes in the 2015 Hype Cycle for Emerging Technologies include the positioning of autonomous vehicles that have shifted from pre-peak to peak of the Hype Cycle. Although this technology is still at embryonic stage, this movement still represents a significant advancement, with all major automotive companies putting autonomous vehicles on their short-term roadmaps.

An interesting example of this is the 'light traffic' project implemented at the Senseable City Lab led by Carlo Ratti at Massachussets Institute of Technology.

The project has developed a conceptual traffic system that would enable driverless vehicles to whizz through intersections without colliding, eliminating the need for signals. Researchers from MIT, the Swiss Institute of Technology and the Italian National Research Council came up with the idea for a new type of intersection called Light Traffic.

Their system would use sensors to keep driverless cars at a safe distance from each other and allocate each car with a crossing slot as it arrives at a junction.[13]

The concept of IoT is based on the presence around us of different objects—as RFID[14] tags, sensors, actuators, mobile phones, etc.—which, through a single language and a unique encoding of names (unique addressing schemes), are able to interact between them to achieve a given objective. The increasing miniaturization and decreasing costs of RFID and NFC[15] technologies, sensor networks, wireless communications has enabled the Internet of Things to acquire an important role in consumer and industrial applications. The NIC, National Intelligence Council, of US reports that "by 2025 many everyday objects will become Internet nodes: from food packaging to furniture, paper documents, and so on".

The IoT technologies have an increasingly important role in the projects for Smart City. A survey of the Observatory Internet of Things of Politecnico di Milano shows the most common IoT applications of the technology. The multifaceted nature of Smart city requires indeed enabling technologies that intrinsically are multi-functional and flexible and that can be employed in different areas.

In this way, it will be possible to limit the consumption of resources and of soil, interconnecting conceptually different infrastructural layers dedicated to support different urban services. In this scenario, the internet of things (IoT) is gaining more

[12]'Hype cycle curve' shows the historical perspective of the market for a new technological challenge, designing the typical curve valid for all economic revolutions: emphasis, disillusion, real business appears, consolidation.

[13]http://senseable.mit.edu/light-traffic/.

[14]In telecommunications and electronics, the acronym RFID (Radio-Frequency Identification) is a technology for identification or automatic storage of various entities: objects, animals or people. In this way, special electronic labels, called tags (or transponders), are capable of storing data and may respond to the query at a distance by fixed or portable equipment, reader or interrogator.

[15]NFC, Near Field Communication, is a technology for low range bidirectional wireless connectivity between apparatus. The operation takes place within a range of 10 cm, but usually is limited to 4 cm or less for security reasons.

and more clearly the role of enabling technology. The Observatory "Internet of Things" of Politecnico di Milano has carried out an analytical study considering 116 cities, including 51 cities in Italy and 65 cities abroad, and 258 different applications for the Smart City supported by IoT technologies. One of the first observations is the fact that many projects are inherently multifunctional, offering the same technological equipment to multiple applications. This characteristic is found in both the Italian projects and in those started abroad. Thus the cost of services is shared among multiple entities that use the same technology infrastructure. The analysis shows that over 30 % of the projects launched in 2012 concerns at least two areas of application, 12 % at least three.

Generally the IoT applications for the management of vehicles traffic are more numerous of others especially in Italy. More than 50 % of the cities has initiated at least one project on mobility; but more recently, as well as applications for the acquisition of geo-referenced data on traffic and monitoring the Limited Traffic Zone, also in Italy the first multifunctional applications are starting.

The Intergreen project in Bolzano is dedicated mostly to vehicular traffic. It aggregates traffic information and some environmental parameters that vary with time and space using vehicles sensors and information from fixed stations. The Compass4D project in Verona, started in 2013, is able to improve fluidity and traffic safety based on communication between vehicles and the traffic light system. In addition to traffic management, in Italy are very frequent projects for intelligent lighting with remote monitoring and remote control of street lamps (13 % of total applications, 30 % of the analyzed Italian cities) and for the collection of waste identified bins, supporting a timely pricing (13 % of total applications, 28 % of analyzed cities). The tangibility of efficiency benefits and service quality is the key factor which explains the large number of these projects.

Other projects at a more experimental level are those for intelligent lighting that integrate video surveillance and traffic monitoring with environmental parameters (Spiga Smart Street project—Milano), or some security solutions that allow, in addition to traditional video surveillance systems, also monitoring crowds and automatic incidents detection (Vanaheim project—Torino).

At international level, it is to report the Smart City Platform in San Francisco which uses the Mesh wireless sensors network scattered around the city for centralized management and remote intelligent lighting systems, Smart Metering and Smart Grid, for the management of the road network, for safety reasons, and to address recharging of batteries for electric vehicles. The highlighted synergies (related to public–private partnership experiences), underlines the IoT Observatory of Politecnico di Milano, "appear in our opinion the only way out of the chronic lack of funds, of the inability of private actors to invest in innovative projects, to create new infrastructures and to manage the difficulty of Municipalities of enhancing their assets and streamline their processes. The European experiences show that a solution can be found. Not doing so would be yet another missed opportunity for Italy".

Another important field of application of the IoT technology is Energy. According to Intel, "If market conditions have driven the development of the smart grid, technological development has enabled it. Fundamentally, the smart grid is an energy generation, transmission and distribution network enhanced by digital control, monitoring and telecommunications capabilities. In addition to providing real-time, two-way flow of electrical power, it also enables automated, bidirectional flow of information". As a result, all the players in the electricity field—from generation plant to commercial, industrial, and residential users—gain insight into both electrical energy and the infrastructure carrying it. Adding intelligence to existing infrastructure means to strategically deploy digital equipment and apparatus to complement existing equipment.

This new digital layer connects all parts of the 'Internet of Watts' that is an example of the internet of things (IoT) technology. The IoT is built by integrating Internet connectivity into all kinds of plant, equipment and devices, connecting those devices in intelligent networks, and using data analytics to extract meaningful and actionable insights from them. In the context of the smart grid, this means distributing computation potential within the infrastructure. This means all things from embedded sensors in wind turbine vanes controlling its pitch, rotation and function in real-time response to changing wind conditions, to substation control apparatus responding fast to any kind of events and reduce to a minimum the production downtime associated with electrical grid disturbances—in both cases without human intervention. Besided, deep insight into consumption patterns through the so called *intrusive* or *non intrusive load monitoring* together with great predictive ability allows more energy saving, including demand-response, time-of-day usage tariffs and real-time pricing. This helps to balance demand and supply while minimizing waste produced by over-provisioning both base or peak load.

8.11 Spin-Off and Start-Up as Tools to Promote the Smart City Growth

According to what has been said until now the technology and more generally the technological infrastructure enabling tools are indispensable for the development of smart cities. But the smart city not only declines as a city/hyper-technological community, but rather as a context in which the technology is at the service of the community in order to achieve a better quality of life. It is in relation to what, in the community projected towards a smart development, one can always witness to the emergence of more "enabling alternative instruments" (start-ups and spin-offs), that relying on collaboration and creativity of human capital become driving forces of this development.

On the other hand, as seen from the experiences described in the previous sections, the economic and cultural development of the territories strongly influences the ability to implement smart solutions in the cities being mutually enabling

technology and culture aspects in intelligent communities. The conscious use of technologically advanced solutions can not exist without a conscious user and enjoyment of the cultural and literary heritage, as well as exchanges between people now passes inexorably through the technological infrastructures.

The synthesis between culture, technology and regional development is a natural place within the business incubators that are also borned alongside the universities and the business realities that arise within them (Spin-off). Another important aspect is that the Spin-offs and start-ups are one of the strategic elements of the European economic recovery together with the consolidation of a solid public–private partnership. Both elements, we could say, are the basis of the Smart Economy and must be supported by forward-looking policies to create efficient infrastructure in communities and generate new business. Another key element is to recognize that skills and innovation are the only drivers of the development of the economy in Western countries. Federico Rampini, correspondent of the journal "La Repubblica" from the US, traces the beginning of 2014 an identikit of the Start-up.

"Startups are young companies in the head, in their culture, though not necessarily in the age of the founders. Innovative, generally with high content of advanced technologies, but not intended to remain small or niche. Startups for the culture of their founders are a thousand miles away from dwarfism of certain Italian small businesses, which in small size have a vocation, often for ulterior motives (more freedom of exploitation and dismissal easier to escape the fiscal radar screens). Hewlett Packard, Microsoft, Apple, Google, Facebook were startups. The term startup for Italians was still an exotic new word when I moved to live in San Francisco 13 years ago; today it is in current use, and this universe must be taken seriously. This is not a rush phenomenon reserved to others (California), not an exceptional dynamism intended for a select few. That's a matter for thought, in the interest of young people: in the United States even before the Great Depression, between 1997 and 2005, the pre-existing companies have destroyed more jobs than they have created (net balance, less a million places); all the new employment has been generated by the newborn companies: more three million recruitments."[16]

In Italy, the National Prize for Innovation, PNI, promoted by the national Association of university Incubators and of business plan competitions between 2003 and 2015 has turned almost half (46.1 %) of finalist projects for the PNI into real companies: 302 out of 637 projects. What just said justifies and makes it more interesting than ever the world of the Startups and the new economy they generate in Western countries. The theme of the smart city is now at the center of innovation.

Most of the recent startups in Italy (last 5 years) according to the data collected by the Association refer to life sciences and health care (31 %), a slightly smaller percentage to industry (26 %) and ICT (24 %) while 19 % to Energy and clean technologies.

[16]Freely translated from 'Dai trentenni la rivoluzione che ci salverà' by Federico Rampini, *La Repubblica*, january 2014.

Some of the most successful Startups, listed in the portal, are the following.

Ennova is a recent startup in the field of healthcare. It is a revolutionary service center remotely allowing for qualified assistance through smartphones, tablets and other devices. Ennova is a company established at the I3P Incubator of the Politecnico di Torino and that won the 2014 edition of the "Startup of the Year", PNI, namely a competition open to young enterprises generated by academic research after 2010 that have achieved the best technical performance and market success. Still in the field of healthcare Drdrin is a platform to support the terapeutic adherence of patients also in case of complex therapeutical paths (the company Biocare is a Start Up of S. Anna and University of Pisa).

VivaBioCell is a company founded as a spin-off of the University of Udine. Winner of the second edition of the National Innovation Award, in 2004, does research on autologous stem cells, which is taken from the patient and replanted in the same person. Its innovative machinery "GMP-in-a-box", has enabled it to win numerous prizes up to attract the attention of Nantcell, US giant focused on the discovery and development of innovative cell therapies, which purchased behind a huge investment.

Fermo!Point is a packs collection service reward that allows those who have withdrawal problems of their expeditions to make them arrive at any of the affiliates points distributed in the territory. They won the 2014 edition of the National Innovation Award, PNI, in the category ICT, because the real engine of the company lies in a web based platform that connects all involved online.

Mangatar is an innovative Game company and publisher of independent developers, it is the new reality of Italian made style gaming, identity, narrative, numbers and creativity. After just 4 years in business, as a result of the PNI 2012 victory, already it boasts a userbase of nearly one million players. In addition, during this short period the company has already received investments and loans for millions of Euros and two very important teams came into the company through a capital increase.

Other startups deal with *smart mobility*.

Clacsoon is a free application that lets you share the transportation through a platform that allows the reservation. The path cost is charged to customers and translated into points. The system allows the accumulation of points by the drivers that are then converted into products or services of their business partners in the project (Green-share LTD).

Kyunsis LTD is rather an established reality in the European scene. Designs and produces innovative systems for smart mobility. It offers a full suite of products SW, HW and RFID for the management and control of parking, permits, concessions, people, urban logistics. It is responsible for Smart Urban Mobility, Smart Parking and Smart Logistics and Mobility over 600,000 distributed Pass. Today it works with Deutsche Telecom and many other partners for the development of projects in various European cities.

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Chapter 9
Sustainable Regeneration of Brownfields

Silvia Pennisi

Abstract Our cities are really rich of building ensembles now deserted which were, in the recent past, sources of job and productivity for the community. They are generally inside the urban fabric or in the suburbs and they are often not particularly taken into consideration because they haven't architectonic characteristics which could justify a restoration. Due to their big extension, the planning approach turns to be diffucult. Besides, these areas, if adequately restored, could become an important economic and cultural resource and a possibility of experimentation of new sustainable technologies. All this heritage requires a planning approach based on conservation and valorization of all the cultural, historical, technological and environmental aspects.

9.1 The Different Matters and Complexity of a Sustainable Regeneration into the Cities

In the nineteenth century and early twentieth century, the suburbs of the main mining, manufacturing and port towns were the favoured place for the installation of great industrial constructions, because they offered large ground areas.

Many large industrial areas which before the second world war were rather far from the residential areas and historical centre, after the war were incorporated in the surrounding urban structure, and only in few cases this process resulted in an excellent combination [1].

From the early seventies many of these industrial areas were divested leaving large unused urban areas.

The causes of the abandonment along times have been various.

The main cause was the conclusion of obsolete industrial activities and the crisis of some of the main industrial sectors.

S. Pennisi (✉)
Dipartimento di Architettura, DARCH, University of Palermo, Palermo, Italy
e-mail: silvia.pennisi@unipa.it

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Another cause was the closing ordered by the competent authorities of polluting activities (mostly in large northern European cities).

The phenomenon of the industrial disposal was studied in different ways in the different geographic contexts in which it happened.

Also the matter of the reuse of the divested industrial areas was a really relevant phenomenon which marked the end of an historical period.

In some countries for many years the heavy industry has had a leading role for the economic development of a lot of European cities.

The issue of the industrial abandonment was studied in United Kingdom, where, in the seventies, a full literature on this matter was produced.

In these studies, reliable estimates were made about the real extent of the phenomenon both at national and international level.

The policies of reuse of abandoned industrial areas were finalized since the beginning of the twenty-first century towards a compact and more dence model and with improved architectonic quality [2].

The wording "brownsfields" has been recently used to underline that this new methodology is finalized to environmental sustainability, in contraposition with the word "greenfields".

In the past, the phenomenon of disposal was caused by the end of production activity, and the process of conversion was characterized by a continuous transformation, with an adaptation of the preexisting structures to the new needs, with a gradual replacement of the buildings. After the second world war, the urbanization process slowed down and in the same way more and more industrial areas were consequently abandoned.

In the contemporary city, the phenomenon is caused by the modernization of services and infrastructures and is characterized by the speed of technological innovation, but above all it is connected with the dynamics of the restoration of some portions of the city.

Another relevant factor is connected with the increasing attention paid to the sustainable and compatible use of the resources of the urban system.

The possibility to reuse abandoned areas inside urban fabrics, strongly congested and often immobilized, gives back the city more flexibility for the increasing demand of space and quality, representing a fundamental resource to the rehabilitation of urban parts strongly congested and often immobilized [3].

Left aside the term "urban void", thanks to the central position and the large dimension of the abandoned industrial areas, such issue became a great occasion to redraw parts of a city, redefine the physical and functional disposition of the city.

The fundamental role taken by abandoned areas in the intervention of requalification was thus included in the broader debate about the urban areas and the new tendencies of the urbanism.

A new thinking about the urbanized environment developed, the requalification acquired a new fundamental role in the urban services, in the renewal of building typologies and above all in the urban quality [4].

A new culture of the transformation has thus been diffused and has put an end to the soil consumption respecting and valorizing the local vocations.

In the beginning of the twenty-first century these areas were acknowledged as having a catalyst role for the urban relaunch.

The recovery, until the seventies, was finalized to the requalification of the single building, then, with the advent of complex urban plannings, the recovery began to consider the urban environment of aggregates of buildings, considering the building typologies and relevant methodologies.

This made the process more complex, lengthening the times and increasing the need of human and economic resources.

It is evident that the problems connected to the requalification of abandoned industrial areas are many and multidisciplinary including economic, social, political and ecological aspects.

The "value" takes a new meaning and is replaced by a wider concept which considers not only the resources that are sold and purchased, but also the resources to which the market doesn't give any value and which have, however, a value connected with their cultural, social and environmental significance.

Designing a sustainable district involves not only the ecological and energy aspects of the buildings, but also the research of a balance between social features—as integration and security—mobility, respect for nature and urban form.

9.2 The Brownfields: Characteristics and Potential

The industrial ensambles, thanks to their extension and strategic location, are a fruitful field for the application of theories of sustainable development; moreover they are urban elements between the urban scale and the building scale.

The activities of the contemporaneity, connected with culture, creativity and characterized by a certain level of immateriality, are above all localized inside the urban fabric, often in strategic zones of the city, which were rehabilitated thanks to the recovery of the ancient industrial areas [5].

Different kind of interventions on industrial abandoned buildings can be indentify: the recovery of original productive functions, if there are the conditions, or the productive reconversion, the reuse with other functions.

Depending on the value which has been given them, the abandoned areas can be used in different ways.

As a real estate resource, they can be finalized to profitable uses and for activate wider processes of urban renewal and development. As urban resource, they can be used to activate strategies for relaunch and territorial reorganization through the localization of important and innovative functions inside the urban fabrics in which there are no free spaces [6].

These places have often been really important for the communities which have seen their life turning for years around these productive realities, and they represent an historical-cultural resource, usable for the intrinsec promotion of the symbolic and historical value, as a place of the memory.

Considering that our cities are chaotic and polluted, the abandoned industrial areas could be environmental resources, usable for the recovery of large spaces and big public services that would relieve congestion in the cities always more and more suffocated by the buildings and recreate the correct equilibrium between urbanized fabric and open spaces.

The buildings realized for industrial use often have structural typologies made to sustain high stresses and dynamic actions.

Their casings are often characterized by brick walls which can guarantee a good thermal inertia. The large internal spaces, with remarkable spans and remarkable internal height, are characterized by a good flexibility and adaptability for new uses.

In addition to the spatial and constructive characteristics, another factor potentially advantageous for the recovery is the location of the building in the urban fabric, which is often inside or near the urban centers, in areas well served by infrastructures.

The awareness of these potentialities of abandoned industrial areas permits to valorize the key role which they perform in the processes of urban regeneration for the many advantages achievable.

These are: the saving of the needed resources for new buildings and a reduction of the ground consumption, the social appropriation of the urban spaces and the maintenance of the collective memory of a industrial past and then of the history of a city, the possibility of insertion of new and different functions as a driving force for a social and economic improvement [7].

In the dual goal to keep track of the past and to satisfy new needs, the conservation must be understood as a project for the current times.

A right approach to a reallocation plan of the abandoned industrial areas must necessarily provide a multidisciplinary and integrated methodology, in which more actors (public, private and specific organisms) should be involved and should cooperate.

An important step is the evaluation of the future uses, which must be compatible both with the potentiality and the characteristics of the buildings and the surrounding context, in physical, social, cultural and economical terms [8].

The industrial complexes, for the fundamental role developed in the places where they are located, are respectable and must be preserved, through knowledge and critical selection of the original features, of the original materials, of the original constructive systems and other finds which are supporting materials of the industrial civilization [9].

9.3 Strategies for a Sustainable Regeneration in Europe

There are many successful examples of recovery of abandoned industrial areas which can stimulate and inspire about methodologies and approach to the projects.

Here are synthetically illustrated some cases, different for dimension, localization and function, but with the common characteristic of showing brilliant cultural

and social results with the involvement of the inhabitants of a district and with positive consequences on the whole near urban fabric.

The ex chocolate factory Barratts Confectionery of Clarendon Road, is in the district of Haringey/Wood Green, in a degraded zone in London, was abandoned in the nineties. The structure, which has an area of 10,000 mq, was buyed by Workspace Group, one of the greatest estate agent of London.

The reuse has been included in the investments of the London Development Agency (LDA) for the transformation of the zone of Haringey/Wood Green in a cultural district.

Without costs of recovery, 5000 mq of the whole complex were given to a no profit local agency which works for the promotion of art and industry, the Haringey Arts Council, today Collage Arts.

This agency, since 1996, created 75 atelier for over 150 artists and after the success of this operation, called Chocolate Factory 1, it destined the other 5000 mq as a support of creative micro industry, with a particular focus on new digital technologies for design, sound, film, video, animation, television, radio, music and photography: the Chocolate Factory 2.

This experiment represents one of the most important artifacts of a creative hub in Europe, which offers spaces for offices and ateliers of different dimensions where young londoner talents can use minimal conditions to trying a professional development, contributing to the requalification of one of the most declassed districts of the city.

There are individual and collective spaces, both in internal and in external zone, also for festivals and events of various type organized by schools and Universities. Some restaurants and shops make the complex usable from all the citizens.

The most innovative element, which is at the base of the great success of the whole operation, is the low cost of the rent, thanks to the use of the unrefined spaces for laboratories or ateliers, the sharing of the space from different artists and the relation with the district.

A particular attention is aimed to the weak part of the society, as ethnic minorities, women, disabled, ex prisoners, which have the possibility to learn and make working experience.

The College Art supports itself with public cofinancing as well as with private financing initiatives associated to the restaurant, clubs or territorial projects.

In the periphery of Barcellona an ex storehouse was abandoned in the eighties and remained empty for years, as long as the Federació Sindical d'Artistes Plastics de Catalunya obtained from the municipality of Barcelona the authorization to use the old storehouse for workshops and artistic activities.

The costs of the rents and sales of spaces had considerably increased after the Olympiad of 1992 then the Federaciò proposed to use the abandoned industrial areas for cultural aims with the intention to sensibilize the public institutions about the problems of emergent artists and possible solutions.

So in 1997 the center Hangar was opened.

The center supports the artists giving them consultancy for the realization and the production of projects, as well as for making an economic and advertisement

planning. The price of the rent is really low, and the center offers also the access to the equipments, the help of specialists and the possibility of accommodation for the artists.

The activities belong to the context of the digital arts, in particular: Visual art, street performing art, multimedia, video production. For these activities Hangar provides for exposition spaces, spaces for festivals and workshops with 14 ateliers, a large space for projects, a studio for video production and different workshop studios. There also are some residences for the artists.

Notwithstanding the fact that Hangar is a private initiative, all is organized with very open criteria. A "call for applications" is published for the artists to start their activity in Barcelona, then a selection is made with the evaluation of curricula and job interviews. The available time for accommodation ranges from 1 month to 2 years. This methodology for managing spaces is unique in Spagna.

The ex pavillon Veljkovic, first private Art Museum of the Balkan, built in Thirties, was used as a storage during the Second World War and abandoned toward the end of the Forties. It was in ruin until 1993 when it was occupied by a group of young with the aim of creating a cultural centre for Belgrade.

The Center for the Cultural Decontamination is located in a territory which lived a terrible fratricide war.

It is based on the idea of tolerance and respect for the diversity through the social and cultural responsibility, against nationalism, xenophobia, intolerance, hate and fear of people.

The CZKd is an independent cultural institution which helps local artists and cultural operators to carry on their ideas and to work with foreign colleagues. All the events, conferences and projects aim to support the information and activities in favor of the minorities and from its establishment it has organized more than 2000 events.

At the same time the recovery of the buildings was realized. The activities are carried on with the management of a little nucleus of specialists, who help also organizations and the embassies to organize events and develop programs [10].

9.4 Guidelines for a Reuse of Abandoned Industrial Areas in the Euromediterranean Region

The reuse of the brownfields can be for the Euromediterranean countries the solution to many problems, as well as a chance for cities to align to the changed needs of society.

In the case of brownfields, the two aspects of conservation and transformation must coexist in equilibrium with the surrounding context: the preservation of memory and the modification as its necessary completion at two different scales: urban and architectural.

At the urban scale, intervention on an industrial area is a true work of conversion that should affect a much larger area than the area itself and its immediate surroundings [11].

A work of urban renewal can have chance of success only if it involves the regeneration of the area and not only its reconstruction.

The territorial redevelopment must emanate from the Self-healing potential of a territory: the starting point are the feature of the existing site, its identity, the life that's in it, the resources and the resident themselves. The redevelopment should be addressed to people, not to property or to the space in its materiality.

Any intervention on the territory, even if it acts on a degraded environment, that does not directly involve consolidated historical cities, must be aimed at a formation of a fully lived space, integrated into the economy but also into the environmental and socio-cultural values.

From the point of view of integration with the surrounding tissue the regeneration should tend to the enhancement of the connecting spaces between the industrial buildings that can have the vocation of public spaces in order to tear down the old fences and allow direct usability from the citizens, the mobility and social aggregation.

Brownfield sites should be seen as a system with characteristics of autonomy and relationship to the urban system, and redesigned planned as a strategic areas giving back to these territories the ability to respond to the new nature of urban change, a fundamental support for their transformation.

In this light, the industrial areas around the city become the catalyst for new developments, of the urban phenomenon of the same system and structural elements, and elements of identity of the city.

The relationship with the surrounding tissue is also an opportunity for redevelopment of the "margins" of the project, whether they have been urbanized in later times to the realization of the industry or whether it had been built within the village [12].

The design for these areas should consider the meanings related to the shape of the space and its materials but also to the social consciousness, the values of history and place.

The integration of the prospects of the companies and community governments is one of the key for better decision making about the future of a territory.

An urban redevelopment is a positive experience if it brings to self-sustainability of the territorial system. The self-sustainability is based on the promotion endogenous development processes that enhance local resources and strengthening of the attitudes of the community to fulfill their needs.

In a process of conversation, it is therefore important to develop innovation networks, forms of organization of the relations between the actors involved through information networks, communicative and cooperative.

An effective project for conversion must therefore be elastic, flexible to adapt to changing conditions of the external environment and the social perception of the community objectives, which also vary with the progress. It should be an integrated

approach based on the synergy between upgrading the physical environment and improving the quality of social life.

The issue of brownfields appears as an important opportunity to test the ability of spatial planning and urban design with environmental mode.

Brownfield sites have been and are by their nature producing pollution, often with important interferences on public health, the soli and the environment.

Before defining the urban destination it is therefore important the classification and analysis of these areas. The particular conformation of Italy resulted in the concentration of human settlements and also in industrial production in lowland and coastal areas that have welcomed both functions.

These areas can be transformed from polluting to sustainable, from a problem to a resource, with appropriate choices.

Besides it seems necessary the integration of traditional and innovative technologies capable of exploiting the inherent potential of the buildings.

Industrial structures often offer large spaces and high roofs showing large surfaces that allow the implementation of active and passive systems for energy savings and lend themselves to flexible design, thus also suitable for testing of technologies and materials for energy efficiency.

The choice of materials is carried out with attention to places, climate and traditions, and local productions, in order to give local economies opportunities for growth.

Particular attention needs to be paid now to the fundamental principles of eco-compatibility and sustainability, not only in the construction phase but also in the management phase.

Both inside and outside built-up areas of old industrial sites represent an opportunity for reduction of soil waste.

In Italy the soil consumption on average is 500 km^2 per year. Over the past 15 years, the soil consumption grew in a completely uncontrolled way, and Italy's physical reality is now composed of shapeless settlement phenomena: widespread extensive suburbs, disordered clusters of residential suburbs, commercial blocks connected by roads.

But, says Legambiente in its report "Environment Italy", that quantifying the phenomenon is not easy, because the databases are heterogeneous and not very up to date, and because the pressure on the land-use is amplified by planning deficiencies and illegal building, characteristic of Italy.

In the logic of the urban reuse, it can be appropriate a choice of compaction and densification of settlement loads, connected to efficient mobility policies and public transport, which allows to meet the needs of development without further impairment of the sole.

The choice of destinations of use is the next step in the analysis of the context and of the buildings that make up the building complexes. Contextual necessity, the history, the urban fabric, the traditions and the participation of citizens will address the necessary information to find the real vocation of the building complexes.

The *social housing* destination is extremely timely in this period when incomes fall, the choice of destination to accommodation and uses associated with social

development is therefore strongly recommended. The placement of these complexes in the city would fight against the marginalization that often characterizes these building complexes.

The link with the community provides the opportunity to turn it into a service area infrastructure, the center of public weaves, the point of articulation for other networks: for example, the network of mobility in many urban industrial areas may represent the point of junction between the traditional and the soft mobility (walking, cycling). The analysis of the quality of these connections is the first issue to be addressed.

Our cities have a particular lack of structures that allow the reintegration of disadvantaged people, such as former prisoners.

Associations working in this field need adequate space to carry out projects, schools and places where learning and producing is possible, favouring a return to the community that otherwise proves to be nearly impossible.

For this specific use the large size of industrial complexes would include both areas for education as well as productive areas or temporary housing.

One of the new requirements of urban spaces is the possibility to host migrants since the existing structures often prove to be inadequate for the purpose, and always insufficient.

The industrial complexes have the appropriate size to ensure functional flexibility and thus these uses seem compatible.

Allocate these areas for social functions also means to turn our attention to new functions and requirements of cities, flexible over the years: aggregation points for young people and neighborhoods with different purposes and variable uses depending on the time that the city is living.

It is important to adopt an analytical cognitive approach, based on a preliminary study of the environment, land and regulations, as currently the laws reveal themselves lacking about the housing market aspects.

Analysis as the basis for meta-design process: context analysis, social analysis, margin analysis and analysis of the limits.

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Chapter 10
Shared Administration for Smart Cities

Daniela Ciaffi and Emanuela Saporito

Abstract Within the paradigm of Smart Cities, the role played by urban communities is becoming ever more crucial. This chapter, in particular, explores the paradigm of "Shared administration" as the most effective urban governance model that helps urban communities to operate as smart communities taking care and regenerating common urban spaces. According to this administrative culture, the "Regulation for collaboration between citizens and administration" and the "Pact" are measures to implement practical opportunities to empower citizens, to free their energies and to enhance their knowledge and competences in a renewed alliance with the public institutions.

10.1 Introduction: Shared Administration Between Smart Cities and Communities

In the contemporary debate on the Smart Cities, the adjective "smart" still refers mostly to cities equipped with advanced technological solutions to meet urban challenges of contemporary times. However, this notion of smart city is very limited. This is even more true, if we think that the revolutionary power of ICT and of new media is, first of all, to have brought to front the "community", or better to say, the communities, as new social subjects, economic actors and, sometimes, even "actual policy makers" [1].

Even in the more sophisticated studies about how technologies can re-shape the cities, what emerges are the infinite possibilities they give to communities, to urban

D. Ciaffi (✉)
Dipartimento di Scienze Politiche e delle relazioni internazionali,
Università di Palermo, Palermo, Italy
e-mail: daniela.ciaffi@unipa.it

E. Saporito
Dist – Dipartimento Interateneo di Scienze, Progetto e Politiche del Territorio,
Politecnico di Torino, Turin, Italy
e-mail: emanuela.saporito@polito.it

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inhabitants, to re-frame urban life style, to introduce new urban living practices, to design innovative solutions for emerging social problems through sharing practices [2]. Smart Cities are certainly more than technology. This notion has to do with environmental sustainability, human capital development and more effective urban governance. In this respect, what makes a city smart is the resilience of its community; is the capacity of its administrative bodies to lever on the "intelligence of democracy" [3], building informed decisions, by empowering local knowledge and by sharing tasks and responsibilities.

In the "sharing" era, a smart city, in fact, should be "competitive" and "creative", but also livable and just. Certainly, within this cultural framework, we need a paradigmatic change in urban policy-making and governance. The authors of this text will explain in the further paragraphs how the "Shared administration" [4] model can help "smart cities" to perform as "smart communities".

10.2 A Recent Innovation of Italian Administrative Law: The Local Regulation on Collaboration Between Citizens and the Municipality to Care, Regenerate, Reuse and Manage Urban and Spatial Commons

What's "smart" in a municipal regulation? A simple but revolutionary innovation: a new organizational model for the public administration based on collaboration rather than conflict [5] between citizens and administrations [6]. This new model is the "shared administration" and the "local regulation on collaboration between citizens and the municipality to care, regenerate and reuse urban commons" is its normative concrete expression. Since 2006, Labsus, the Laboratory for the Subsidiarity, a noprofit Italian organization made of jurists, public policy analysts, sociologists and researchers, has studied the horizontal subsidiarity principle, supplied in article n. 118[1] of Italian constitution since 2001, and its practical implications, for legitimizing active citizenship and empowering urban communities.

The "local regulation on collaboration between citizens and the municipality to care, regenerate and reuse urban commons" was introduced for the first time by the City of Bologna [7] in February 2014,[2] and since then almost other 60 Italian municipalities have adopted it. Its heart is rooted in the art. 118 final paragraph, where is clearly stated that the public authorities promote the autonomous initiatives of citizens to carry out activities for the general interest. This statement recognizes that these citizens are not just users, clients, administered, according to the categories

[1] "States, regions, counties, municipalities, metropolitan cities and town councils prefer citizens to take independent individual or collective initiatives in order to develop activities of common interest, based on the principle of subsidiarity" (Article 118 of the Italian Constitution).

[2] The full English text of this Regulation is available on http://www.comune.bologna.it/media/files/bolognaregulation.pdf.

of the traditional administrative law, but that they are individuals who work with the administration in the general interest pursued or, said another way, in the care of the commons.

Within a shared administration framework, public administrators and citizens are equal and are allied: a public organization model that entitles urban communities as "smart communities", bearers of competences, knowledge, passion and energy to cooperate with the public. The lifeblood of the shared administration are hence the people, those urban inhabitants who perform as "administrators for fact" when they develop precise innovative solutions for complex social and spatial problems.

10.3 Crossing the Public, Private and Third Sector Energies Through Pacts

The "Pact of collaboration" is the smart tool designed to make the principle of shared administration real and to associate it with the everyday life of citizens and policy makers. This pact is a simple agreement among contractors characterized by various profiles such as local elected politicians, technical staff employees from the municipality, members of formal associations, people taking part in informal groups, volunteers, private subjects, stakeholders. The pact is a short document in which contractors share the responsibility for initiatives to take care of, regenerate, reuse and manage commons. This document contains all the details about the reasons, the object, the methodology and possible locations for concrete implementations.

Indeed, these few pages are not just a simple operative agreement: in the Italian administrative culture, this governing change represents a sort of silent revolution at different levels.

First of all, the introduction of a set of rules that involves active citizens coincides with the promise of reducing bureaucracy.

As an example, Italian cities, that are now creating a network of shared administrations, are providing a more intelligent way to prevent active citizens from following long bureaucratic procedures. This is a first type of innovation concerning speeding up the public feedback in response to the growing effervescence of practices designed and implemented by the communities after the crisis [8].

The step forward is much more courageous, because it implies a radical change of attitude for the contractors: everybody has to become equal to the others partners moving from his/her own traditionally hierarchical role. The pacts may be more or less complex but they are always peer to peer. This prerequisite means that the institutional and social culture is shifting from an authoritative model—in which there are those who govern and those who are governed—to a new collaborative model. According to this new form of agreement none of the participants may dissolve the pact at any moment by virtue of his/her power.

The regulations through the pacts are simple tools to restart blocked dynamics and to free energies: the contractors forge a written alliance and test it on the field. "The proof of the pudding is in the eating! Let's test these collaboration agreements.

We see how they work, what problems arise and then eventually introduce the modifications based on experience" used to say Gregorio Arena to get people in the mood for this particular "learning by doing" process. He's been leading for over 10 years Labsus[3] as a platform that collects hundred of virtuous examples of shared administration models in Italy.

10.4 High and Low Level of Collaboration and Smartness

According to the "Shared administration" paradigm, urban communities act in a smart way, when these are enabled, through the "Pacts", to collaborate and to take action for the general interest. If we frame this assumption in a "smart city" perspective it becomes interesting, hence, to investigate how technological innovations can contribute to enable and enhance active citizenship. By looking at contemporary "smart practices", it is possible to identify four scenarios of potential relationships between different levels of and collaboration and technological innovation, "smartness" [7].

Low level of collaboration and low level of technological innovation. Despite the dominant rhetoric on shared cities and sharing economy, this is still the most common scenario in Italian cities.

High level of collaboration and low level of technological innovation. In this scenario, what matters is the interaction between decision-makers and other urban actors around a "low-tech" object. An example are co-design processes of urban bike lanes, as smart solutions for sustainable urban mobility; or collaborative initiatives for ensuring wi-fi networks in the public urban space.

High level of technological innovation and low level of collaboration. Here the reference is to those practices that focus on technology and innovation as the goal, rather than on fostering and encouraging new alliances between urban actors. This is evident when we think about green architecture projects. Many of them propose alternative solutions for urban living, by placing gardens, trees and orchards on the buildings, but without involving the inhabitants neither in the design phase, nor in the tending phase of the "smart green".

High level of technological innovation and high level of collaboration. This is the last and most desirable scenario. The "smartness" of this family of practices and approaches to the "production of the city" occurs when feedback-loops between decision-makers and citizens are continuous and on real time.

Today, ever more "Pacts of collaboration" are about more or less advanced technological projects.[4] A good practice is, for example, the Pact "Reducing Digital

[3]Labsus stands for Workshop on Subsidiarity. It was born in 2005 as scientific Law and Sociology on-line review (www.labsus.org); it takes the form of cultural association voluntarily working as consultant to the cities and the groups of citizens and associations interested in applying the concept of Shared administration through the pacts of collaboration.

[4]The most of them have been signed in Bologna, that is still the leading city in terms of "Shared Administration". See www.comunita.comune.bologna.it.

Divide. Sportello Informatico per il cittadino"[5] for the City of Bologna in Italy: a project to alphabetize new digital users, through direct assistance to fragile categories of citizens (elder people, immigrants, etc.). Despite the low level of technological innovation, there has been high collaboration between several actors[6] and a quite relevant impact on citizens' engagement, especially if we think that this project was scaled in more than six different neighborhoods in 1 year only.

Futuratrento.it[7] is an even more advanced practice, that combines in a very effective way technological innovation with collaboration. The City of Trento in Italy has just adopted the "local regulation on collaboration between citizens and the municipality to care, regenerate and reuse urban commons" and Futuratrento.it is its main facilitative tool. In particular, it is conceived as a crowd sourcing interactive platform, where active young citizens can meet and match on-line to co-design, communicate and promote projects for the care and regeneration of urban common goods.

Finally, also architects and designers are discovering the importance of combing design solutions with collaborative processes. Not surprisingly, these experience are defined "Architectures from the Front", like in the Biennale of Architecture of this year, as to emphasize the uniqueness and the radicalism of similar projects. But also, as to focus on how "taking care" [9] means to reframe the design process, towards innovative collaborations for the common good [10].

What emerges from these few examples, is first that combining high level of technological innovations with high levels of collaboration is possible; and then that this alliance could reshape the concept it-self of "smart city".

10.5 What's Going on in the Italian Pilot Cities and What Could Happen in a Smart Perspective

Many participatory experts in Italy express interest and curiosity about the concept of Shared administration. The "Regulation for the collaboration between citizens and administrations" and the "Pacts" are generally understood by designers, architects, urban and spatial planners as means to help meeting contemporary urban challenges. In fact, on one hand the shared administration fits very well into the dominant rhetoric of the Sharing economy [11]. On the other, it follows the widespread trend of the Smart city [12].

ICT for more sustainable cities rarely are the object of pacts of collaboration between citizens and administration, even in the most advanced smart Italian cities

[5]See http://comunita.comune.bologna.it/rdd-reducing-digital-divide-sportello-informatico-il-cittadino-quartieri-porto-e-saragozza.

[6]Just to have an idea of the actor network in this Pact, the signers were more than 6 different ngos, 5 local education agencies, public offices, etc.

[7]See https://www.futuratrento.it/futuratrento.

that have adopted the Regulation. This is because ICT is not the goal, and the literature agrees in avoiding this technocratic attitude. What could happen and what's happening is that the subject of the pacts could be and actually are the (smart) communities and the (smart) administration. The main theme is governing the commons in a smart peer to peer way, as the evolution of local institutions [13].

The desired effects of the shared administration depend on contexts, but the recurrent goals are the discovery and the aggregation of resources, enabling creativity and fostering collaborative communities and economies. There is a relationship of reciprocity between the inputs that may come from new technologies for more sustainable cities and the large number of inputs coming from the shared administration, that can stimulate ICT [14].

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Chapter 11
A Holistic Vision of Smart Cities: An Opportunity for a Big Change

M.L. Di Silvestre

Abstract The depletion of energy resources on the one hand, and the population growth on the other, forced the society at all levels (local, national and international) to turn its attention to the identification of new forms of protection of the environment and the waste reduction for a new eco-sustainable way of living. The process of massive urbanization already in place, exacerbated by the movement of large masses of people in search of a more human form of life, is putting severely under test the livability within our cities, bringing out the inefficiency of existing management and organization models. Daisaku Ikeda said: "Certainly, the density of urban populations means that problems are concentrated in one place, as is the ecological burden […]. Although the world's cities only occupy two percent of the Earth's land area, they account for 75 % of carbon emissions and more than 60 % of energy consumption. While this means that cities' environmental footprint is disproportionately large, it also reflects the reality that if cities change, the world will change". The emerging model of the Smart Cities and relevant technologies, however, pose big questions about its social and *spiritual* sustainability. The Eastern view of the world, however, provides a unifying perspective of science and religion by healing the rift that has emerged over time and that was reflected in many Western cultures and reverberated in many community development models.

Since 1983, on January 26th of each year—in commemoration of the day of the founding of the Soka Gakkai International of which is currently the President the Japanese Buddhist teacher Daisaku Ikeda, a "Proposal for Peace" is sent from the President to the United Nations and to most influencing people around the world. The writings shall look at all the problems that humanity is facing, and highlight—besides the possible solutions—also the philosophical basis that can support and promote a radical change. Much of the material in this chapter is taken from [1]

M.L. Di Silvestre (✉)
Dipartimento di Energia, Ingegneria dell'informazione e Modelli maematici (DEIM),
University of Palermo, Palermo, Italy
e-mail: marialuisa.disilvestre@unipa.it

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11.1 Can Smart Cities Be Really Inclusive?

Since the beginning of the twenty-first century, research and studies identify a viable future in a scenario in which, thanks to the deep ongoing climate change, only in environments organized in an intelligent way, recalling the Smart City model, it will be possible to maintain sustainable aggregated forms of human life.

The intelligence that must show the city seems to find a reading through the massive infiltration of advanced technology in the city management processes, something that is made possible by computer technology developments and telecommunications in recent decades, in a vision which emphasizes the role of connectivity and smart technologies, around which all other spheres of society can be developed.

But the redeeming feature of technology, which also succeeds in many areas to make possible what seems impossible in nature, is not enough to appease the spirits about the concern of a livable future for humans. It is undeniable the fact that, thanks to scientific and technological progress, the world has changed. Technological development and innovation have led to make great strides forward in mechanization and in trade, but also caused the depersonalization of work and increased social inequalities.

Technology that is targeted only to the technical realization of the material well-being, which has as ultimate objective the physical and economic well-being and the technical operation of organizational gears of our communities, seems to engender a feeling of disconnection with the "spiritual" dimension of life. The latter traditionally (although in an extremely simplistic vision) has been considered as opposed to material needs and now seems to be placed in "luxury good" position, not suitable for those with urgent needs to resolve the fundamental problems of everyday life, survival and subsistence, to satisfy spiritual needs.

But there is more. Researchers and scholars of this new urban phenomenon [2] are focusing on new social models that tend to emerge in the contexts in which the massive penetration of advanced technologies is the excellent cost-effective service, and their possible impacts on the social fabric, even based on the analysis of reality to exist today.

They draw attention to the exclusionist side that can be associated to the concept of smart cities: the form of *governmentality* (the word combines the act of governing and the mentality behind conducting governance) can become "highly selective from the social point of view and has the potential to disrupt profoundly the dynamics of social systems, while pushing those who are already marginalized by the knowledge economy even further to the margins of society [2]".

In a reality in which the value is weighed in terms of economic turnover and position in the world economic scenario, all the strategies, tactics and actions of the various stakeholders (local administration, private sector and citizens), are synergistically conveyed in purpose of creating a human and moral appropriate environment, which makes it able to compete in the global economy.

Desirable citizens in this context are those that can become "actively seeking factors of production" [3]. Citizens are encouraged to behave in a way that maximizes the productive time. The sense of responsibility is pleased directing their lives toward economic criteria of efficiency and business calculations.

In this way, the scale of values of the various professions in urban areas changes and skill requirements change too. Knowledge experts will be required taking advantage of the technological competences not to loose the new rhythms of profit creation.

The primary mission of the smart city becomes to free the citizens from the non-productive activities so that they can turn their attention to more "valuable activities", referring to various activities using the brain, while the "not valuable work" (so-called 3D-work, acronym for hard, dangerous and dirty professions, especially in the manufacturing and service industries) are more and more candidates to be replaced by technological systems.

In [2] Olesya Benediktb said that: "the new smart urban trend seems to be shaping up to produce ideal sites for the implementation of such *subjectivisation* processes", fueling a social gap between increasingly exasperated unprecedented wealth of some, and marginalization and exclusion of more and more vast masses.

As written by the Nobel Prize for Peace Adolfo Pérez Esquivel [4]: "We live in accelerated times, subject to mercantilism that creates slaves: in a time of change in the consciousness and needs of civilization, which changes the paradigm of life. The values have changed: our civilization based on profit has rejected spirituality. People do no more build temples, but banks and large financial companies of production and exploitation of assets and natural resources". The industrialized nations are facing a serious spiritual impoverishment, a kind of soul desertification. In this new and complex environment, "which is the role that religion should play in contributing to human welfare? How can religion respond to the basic needs of the people and to a deeply rooted insecurity? What are the requirements for a world religion? Every religious doctrine has a duty to consider and provide answers to these questions. The fact that, in recent decades, a growing number of people around the world is re-examining the meaning of religion, may be considered an evidence of a growing awareness that the origins of our present crisis must be sought in the human spirit [5]".

The theme of the relationship between religion and science and the challenges it poses in the current techno-scientific society, which involves very complex and sensitive issues, it is always subject to debate. On the one hand, science (and technology that objectifies the insights and discoveries), on the other, the spiritual dimension of ethics that seems to find no place in mechanized dynamism of increasingly virtual and automated daily living, in an oppositional dualism pushing to demonize technology development and to yearn to take a step back.

As if the targets were kept on different levels: on the one hand, the material well-being with the wild ride to the fulfillment of all desires, the other the spiritual well-being in a dimension that is detouched from the concrete reality of life. But there is a different way of looking at things. Also for the future that seems to find the new way to experience urban living. The concept of Smart City today has

evolved from its original model. It has been enriched by a holistic approach that is in the inclusion of civil society as unifying element allowing encountering and growth, interaction between industrial parties, local government and scientific research, aiming to sustainable development in social skills and relationships.

The key to reunion between "technological being" and "spiritual being" is in this holistic view. The real possibility of success of the revolutionary smart way to create a community, infact, sees the city as a microcosm in which nothing and no one is left behind alone, but in which all aspects of life acquire equal dignity in the contribution to the common good. In the intelligent community there are no distinctions between "valuable" citizens and others that are "not valuable" based on the type of job, economic wealth, acquired knowledge. In this community, each person is valuable because of his specific "mission" while living in the environment. A Smart City that is built for humans, and not in the interest of technological systems themselves and of those who sell or produce them.

Even science, revealing in recent decades new and deeper interrelationships between things, has given the humans' thoughts new acuity and the ability to overcome the dichotomous thinking between science and religion through a unifying vision that contemplates both in an integration which amplifies the value.

The American physicist Fritjof Capra, systems theorist and internationally reknown essayist, writes [6]: "… Exploring the relationship between modern physics and the basic ideas of the philosophical and religious traditions of the Far East, we see how the two fundamental theories of twentieth century physics—quantum mechanics and the theory of relativity—both force us to see the world in a way very similar to that of the Hindus, the Buddhists and Taoists, and how this similarity is more pronounced when looking at recent attempts to unify these two theories in order to describe the phenomena of the submicroscopic world, that is the properties and interactions of subatomic particles of which matter is composed. Here the correspondences between modern physics and Eastern mysticism are even surprising. […]".

Physics today leads us to a sort of reunion with the ancient wisdom of the East, for which the most important feature of the conception of the world is awareness of the unity and mutual interrelation of all things and all events; the realization that all phenomena of the world are manifestations of a basic oneness.

And again: "The Eastern thought [6] provides to the theories of contemporary science an important and coherent philosophical reference: a world view in which man's scientific discoveries can be in perfect harmony with his spiritual aspirations and his religious faith. […] The more deeply we penetrate in the microscopic world, the more we realize that the modern physicist, similarly to the Eastern mystic, has come to regard the world as a set of inseparable components interacting in constant motion and that man is an integral part of this system".

Eastern traditions, while breaking in a large number of subtly interwoven spiritual disciplines and philosophical systems, constantly refer to this ultimate reality, indivisible and dynamic, which manifests itself in all things, and of which all of them are a part.

11.2 The Interconnection of Life and the Power of Change It Has

Buddhism provides a philosophical basis for the symbiotic coexistence of all the things that interact with reciprocity to form a living cosmos. Based on the principle of dependent origination, it considers the world as a network of relationships in which every individual being works with the aim of creating an environment that sustains all other existences: the world from moment to moment is formed and shaped by this mutual interrelation.

To explain the interconnectedness of life, the Buddhist canon provides the metaphor of Indra's net (Sutra of the Flower Garland): "Far away in the heavenly abode of the great god Indra, there is a wonderful net which has been hung by some cunning artificer in such a manner that it stretches out indefinitely in all directions. In accordance with the extravagant tastes of deities, the artificer has hung a single glittering jewel at the net's every node, and since the net itself is infinite in dimension, the jewels are infinite in number. There hang the jewels, glittering like stars of the first magnitude, a wonderful sight to behold. If we now arbitrarily select one of these jewels for inspection and look closely at it, we will discover that in its polished surface there are reflected all the other jewels in the net, infinite in number. Not only that, but each of the jewels reflected in this one jewel is also reflecting all the other jewels, so that the process of reflection is infinite. […] In the same way, every object in the world is not merely itself but contains every other object and in fact, it is anything else [7]".

The wonderfully complex threads and jewels of the infinite network overhanging the heavenly palace of the god Indra (Shakra Devanam Indra), a symbol of the natural force that nourishes and protects life, represents the deep correlation between every living entity. The Buddhist allegory of the Indra's Net describes well the sensitivity of the natural ecosystem on Earth and its susceptibility to environmental degradation: the resistance of the entire network is given only by the thin network of connections between the various nodes that constitute it, in a balanced relationship between them. If the network is severed at any point or if any of the jewels is removed, the network would risk collapsing [8].

This mutual interconnection exists in nature, in the relations between human beings and the environment, between the individual and society, parents and children, husband and wives. It is a basic principle of Buddhism: the uniqueness (or inseparability) of the person and environment.

"Environment is like the shadow and life as the body without the body there can be no shadow. Similarly, without life can not exist environment, even if life is supported from its environment [9]". If life and environment are inseparable, then our every action has invariably an effect in the environment and other living beings, as well as every action performed by others, even seemingly distant, somehow influences our existence. Each of us is a node of an infinite network of mutual relations. And when a node moves, everything starts moving creating a vast ripple effect, as happens when the shining jewel attached to a magnificent Indra network

moves in the wind by shining the other of a myriad of different colors [10]. This is the reason why our every inner change results in a change in the environment in which we live. Whenever we are dedicated to our human revolution and we are committed to helping other people, there will inevitably be a positive change in society.

When we understand this and can sense in the depths of our being the fact that we live [1]—that our existence is made possible—within this web of relatedness, we see clearly that there is no happiness that only we enjoy, no suffering that afflicts only others. In this sense, we ourselves—in the place where we are at this moment—become the starting point for a chain reaction of positive transformation.

11.3 The Importance of Education to "Collective Humanity"

The Buddhist approach to life offers us, therefore, an important key to understanding the role that civil society can play in achieving the objectives of sustainable development, showing a real opportunity to change the present situation that points to a better future.

"This palpable awareness of interdependence provides a framework or set of coordinates by which to reconsider the relationship between self and other and between ourselves and society as a whole [1]", making us *the starting point for a chain reaction of positive transformation*.

The vital trend of a society is reflected on the environment and modifies it; simultaneously, the environment acts as external cause on the lives of living beings [11]. In this context, the value of education as a creator of value plays a fundamental role. Education has the task of encouraging a more open and universal concept of humanity. The problem is strongly felt internationally and debated for years. In the "Declaration on the education and human rights" that the General Assembly of the United Nations adopted on 19 December 2011, appears an obvious connection of the theme of education to human rights with the need for responsible global citizenship: "Education and training to human rights is essential for the promotion of universal respect for and observance of all human rights and fundamental freedoms for all [12]".

In the revolutionary thought of the Japanese Tsunesaburo Makiguchi, humanistic education pioneer, the educational revolution leads to a wide range of social revolutions. In this revolution, an important role is played by the place where we live: the revolution indeed starts from our environment, from the domestic context, by the street where we live, the office, the district and on to larger and larger sizes.

"Human life itself is a process of value creation and education [13], with its methods, it should guide us towards this end. The more we reflect on the importance of this in relation to the social context, the more significant it becomes a conceptual clarification of the value. […] It should be apparent that, for better or for

worse, we are what we learn, and thus there is more than one reason to choose an education that makes us better."

Today, the global community and its political agenda have begun to focus attention on what can be called "basic needs", i.e. health food, housing, water, education, livelihood and employment.

Among the basic needs, even spiritual needs must find a place, so that we can give a completeness to the concept of well-being and quality of life. To this must then be added the theme of education in economic and social terms but also of spiritual education and of recognition of the value of life.

The role of religion is inseparable from the individual and its environment. As claimed by Mahatma Gandhi, religion "provides a moral basis to all the other activities that would otherwise not would possess. In order to lay the foundations of peace and stability for humanity in this age of rapid and chaotic changes we must be a committed to create a new sensitivity to the pain of others, against narcissistic selfishness, projected towards a universal brotherhood [14]". Bringing people to the highest human values, promoting the dignity of life, pointing to humanistic education, can help to give the impulse to a renewal and be the source of creative energy to transform the era in which we live.

In his 1930 work Soka kyoikugaku taikei (The System of Value-Creating Pedagogy), describes three different ways of life as human beings [1]: "a dependent way of life, in which a person is typically unable to sense their own potential, giving up on any real possibility of transforming their current situation and instead passively accommodating themselves to others and their immediate surroundings or to the larger trends in society; an independent way of life, in which people have the desire to find their own way forward but tend to have little interest in those with whom they are not directly involved; infine, un modo di vivere contributivo". For his part, Makiguchi asserted that the way of life to strive for is a contributive one. "Authentic happiness cannot be realized except through sharing the joys and sufferings of the masses as a member of society".

The key point is to start to regain our innate collective humanity, focusing on education for global citizenship. The purpose can only be to raise awareness of the unlimited possibilities and the importance that can have every single life.

11.4 What Changes the World Readings?

The perspective outlined above, the rethinking of urban areas in a smart view provides the platform for making this possible, and thanks to the opportunities offered by new technologies, provides the tools to reach every individual.

In this times a profound change is happening, and, as always, it brings a great opportunity. There is no universally valid formula for eco-sustainability, the only certain thing to do is to "guide" the transformation process towards the creation of a new era, through concrete actions in the community where each of us lives.

Mahatma Gandhi said: "Be the change you want to see in the world."

This opportunity for a big change through smart cities cannot be missed, recognizing the importance of the valuable resource from which the Smart City can take advantage: the "social capital" of interconnection and networks between people living in organized communities. In these people with attitudes and different characteristics can give their contribution: "It is indeed in the encounter between people whose paths in life have differed that our eyes are opened to vistas that would not otherwise have been visible […]. The friendship and trust nurtured through the committed pursuit of this process can form the basis for a solidarity of ordinary citizens working to resolve global issues and bring into being a peaceful world [1]".

Promoting the development of the individual as a responsible member of society of the City and an active part of gear that moves, it is the right direction towards the empowerment of ordinary people. To enable each individual to discover his great ability to influence the environment in which he lives, is an important key to turning the tide of history.

"As cities initiate action and efforts begin to bear fruit [1], local citizens will be able to gain a palpable sense of achievement. This will provide conviction and pride that will further inspire individuals to take part in the endeavor, building greater momentum toward a sustainable society".

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Chapter 12
A Theological Perspective Towards Smart Communities

Carmelo Torcivia

Abstract When you sit at the table of the different skills that address the sensitive issue of eco-sustainability of our cities and, more generally, human civilization, theology is often absent. The reasons are well known and are cultural and ideological. The decision to invite to this table even theology is then welcome if it involves enrichment of perspectives for all citizens, believers and non-believers. The basic idea that guides the direction of the chapter is that the basis of any conception of the smart-city there is an anthropology that is not only in the ultimate foundation of all reflection, but that in fact is necessary for continuous monitoring of what you go thinking and creating. The theological perspective that guides this article is based on an agile commentary on the first two chapters of Genesis, where are two distinct stories of creation of the world (Gen. 1, 1–2, 4a e 2, 4b–25). The choice to comment on some passages of these two biblical accounts is not accidental. It dictated, in fact, is the foundational biblical reflection that plays for each sound theology is the "secular" significance that the Biblical text has at least for all of Western culture. From this agile comment followed by a second part on certain issues addressed in the encyclical by Pope Francis "*Laudato si*".

12.1 The Stories of Creation

At the beginning—at least with regard to the literary place— of the story of creation (Gen. 1, 1–2, 4a) the author imagines that God fulfilled all its articulated work of creation in a week's time.[1] Within this weekly planning, the author includes the creation of terrestrial animals and of man and woman on the sixth day and the

[1]For a narrative-anthropological reading of the first three chapters of Genesis cfr. A. Wénin, *Da Adamo ad Abramo o l'errare dell'uomo. Lettura narrativa e antropologica della Genesi. I. Gen. 1,1–12,4*, EDB, Bologna 2008, pp. 13–92.

C. Torcivia (✉)
Pontificia Facoltà Teologica di Sicilia and Dipartimento di Giurisprudenza, LUMSA University, Palermo, Italy
e-mail: ctorcivia59@gmail.com

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creation of the Sabbath on the seventh day. We wondered why, despite the well-known centrality of human creation (the term "adam" is not a proper name, but is an abstract noun meaning "human", "humanity"), the sacred writer did not place it on the seventh day, coming to the climax. Not only that, it can seem also strange that on the sixth day are first created some animals and then man and woman. It could, in fact, be more significant if it had just created the human.

To the first question has already answered recently a prominent Protestant theologian Jürgen Moltmann [1]. He claims that, because of its intrinsic meaning, the Sabbath is the time limit of human activity. Thanks to Saturday the man and the woman learn that there is a limit to their work, that not everything can depend on them, they have to be careful at every possible megalomania. If the man and woman together have been placed on earth by God to govern it, they have to remember though that every week there is a "Sabbath" that requires them to stand still, to limit energy, works and even steps to take. They will develop as well, on the Sabbath, human relations, the friendly conversation, family and fraternal conviviality, praise to God. There is a limit to work. There is an ecology of time to remind the human all the beauty of his being a creature, marked by the intensity of his limitations. A limit not to reject or always to be overcome, according to the myth of Ulysses who has crossed the centuries of Western culture, but to love because revelatory of the profound identity of the human. A limit not to be exceeded in fact, under penalty of falling into the curse of arrogance (*hybris* of the ancient Greek tragedy).

The second question can be answered taking into account the other meaning of the term "adam": Earth. If on the fifth day God created birds and fishes, that is, animals that populate the skies and waters, on the sixth day God created the animals that inhabit the earth and the "Earth" par excellence: the human. As if to indicate that it is not possible a full human understanding to exist without the understanding of the constitutive relationship of the same human being with animals and—why not?—With all of the positive animality it is recognizable within the same human being. No angelism, then. No attempt to escape their earthly being.

Not only because every human being should remember that "you are dust and to dust you shall return" (Gen. 3:19)—and that life must be lived by walking in company with the experience of death—but also because it was created together with the land and the animals. The adam then has to deal with animals in order to be what he is, even if he needs, in truth, to stand out from the animals and they can not be recognized as feasible because they are truly companions of his solitude (Gen.2, 18–20), and although he is called to dominate especially the creeping on the ground, that snake that talks like a human, telling lies about God and about the human (Gen. 3, 1–5), to avoid becoming itself a serpent, namely to get a negative animality.

And what he is, God will tell to him: the adam—man/woman—was thought of as "with image and likeness of God", that plays a role of governor of all is on the face of the earth. As had already happened in the preceding verses (Gen. 1, 14–18) as regards the sun and the moon, which had been placed in heaven to rule respectively day and night, such as it happens for the earth, where the human, in the double articulation of male and female, is called to play the role of the government

of the earth, in place of God that is doing its memory, the human becoming himself memory of God.

Within this function of government (Gen. 1:28) the human has the task not only to be fruitful and multiply, thing that the human being shares with the animals, but also to fill the earth and subdue it. The latter task, which in Latin is termed with the happy expression "*dominium terrae*", while it has well shown the work of human government with a clear role of addressing culture, science and technology, on the other side has lent especially in recent centuries a sort of undue "authorization" more or less divine towards the human because he would do and undo what he wanted. Put it simply: the ecological issue has asked theology.

To the extent that it was required to graciously "force" Bible scholars and theologians to speak of "mild domain" and not so much of "domain", which in the Italian language is a strongly characterized as a negative term, but rather to "care for creation", recovering even a beautiful and profound Franciscan line.

It was thus needed to rethink—and in depth—the role of man in the whole wide world, so as to avoid any anthropocentric fall. It has indeed been observed that a mentality and antropocentrical practices produce a whole series of vast problems from the ecological point of view. Man, especially the Western man, from the evaluation of its specific features such as privileges, has drawn anthropocentric conclusions: on the one hand, the knowledge that he is the subjective pole of attribution of all that exists in the natural world and, on the other, has formed the conviction that nature is a simple means at its disposal […]. The anthropocentrism is the theoretical node and fundamental problem of the reaction of ecologists and environmentalists. These increasingly accuse the man of being the source of technological arrogance and glimpse a possibility of solution in overcoming the anthropocentric view of reality [2].[2] Not only this but also the technology, or rather a certain dominance of technology, is impeached.[3]

It is interesting to note that the smart city vision is in line with the concept just treated. A city, in fact, that is redesigned in order to increase the quality of life of its citizens, by restricting the use of land and resources, not necessarily results in a hyper city, rather it seems to be an attempt of a balanced expression between anthropocentric (often resulting in an exercise in science and technology being end in itself and can also limit the relationship between man and urban environment and the "care for creation") and ecology thorough an approach which sees citizens to be conscious actors in choosing less energy-intensive and more sustainable lifestyles.

The "intelligent" attribute (*smart*) underlines the growing importance of information and communication technology (ICT) and the main role of the human heritage, of education and training in urban development.

The smart city implementation not only depends on the city's physical infrastructure (physical heritage), but also, and increasingly, on the availability and

[2]For the entire reflection see to cfr. pp. 23–33.

[3]Cfr. Ib., pp. 33–39.

quality of communication of knowledge and social infrastructure (intellectual and social heritage).

12.2 The '*Laudato sì*'

In this theological renewal line of both mentality and practice fits the reflection of Pope Francis offered in his encyclical letter "*Laudato si*" (24/05/15) [3]. Francis believes that in order to have a real care of the world understood as a "common home", it is necessary that the ecologist problems are linked to economics and social justice. Only harmoniously combining these different instances you can think of a real cure of the common home.

And so, in n. 117 of "*Laudato si*", the Pope states that the lack of attention to measuring the damage to nature and the environmental impact of decisions is only the obvious reflection of a lack of interest to acknowledge the message that nature carries inscribed in its own parts. When you do not recognize in the reality the importance of a poor, of a human embryo, of a person with disabilities—to give just a few examples, hardly you will listen to the cries of the nature itself. Everything is connected.

If the human being is declared independent from reality and is an absolute ruler, the very basis of its existence crumbles, because "instead of carrying out his role as a cooperator of God in the work of creation, man replaces God and thus it ends up provoking a rebellion of nature" (John Paul II, Centesimus annus, n. 37).

It is a very interesting perspective because it claims the need to recognize the structure of reality where "everything is connected." The recognition of this fact, in itself so simple as having to appear almost trivial but unrecognized as an effect of thousand interests of powerful groups and the distortions by old ideological systems, is crucial because it creates the path that every logical and intelligent structure should follow to build not only a real city for humans, but also to build a city where stones, plants, animals, men and women are crossed by a light that creates harmony.

From the perspective of ecological reflection, then, the Pope believes that the ecological culture can not be reduced to a set of urgent but partial responses. Humans must instead meet on the grounds of a serious philosophical and theological anthropology.

Here is a great merit of this encyclical. In fact it could be thought of as an argument on some important human problems with an indication of some solution track.

And it certainly would have its own sense and a remarkable consensus.

And instead, the even bigger advantage is the fact that this encyclical presents a vision of unitary man to which the connection with the common house of the earth must match. In this sense, it is good to read the following reflections drawn from the same encyclical: "The ecological culture can not be reduced to a series of urgent and partial answers to the problems that arise with respect to environmental degradation, depletion of natural reserves and pollution. It should be a different

look, a thought, a policy, an educational program, a lifestyle and a spirituality that give shape to a resistance against the advance of the technocratic paradigm. Otherwise, even the best ecological initiatives may end up locked in the same globalized logic.

Looking only for a technical remedy for every environmental problem that occurs means to isolate things that in fact are connected, and hide the real and the deeper problems of the world system.

We can, however, once again broaden our vision; human freedom is capable of limiting the technique, and of ordering it and putting it at the service of another kind of progress, healthier, more humane, more social and more integral.

Liberation from the dominant technocratic paradigm in fact happens in some occasions. For example, when the community of small producers opt for less polluting production systems, supporting a model of life, of happiness and conviviality, not consumerism. Or when the technique is geared primarily to solve the concrete problems of the others, with a commitment to help them to live with more dignity and less suffering. And even when the creative search for beauty and its contemplation are able to overcome the objectifying power in a kind of salvation that takes place in the beauty and the person who contemplates it" (nn. 111–112 [3]).

This long quotation allows us to understand very clearly that humans must first take away from a "technocratic" paradigm. This is, for the Pope, the contemporary idol to which many women and men sacrifice their lives.

It is often a structural paradigm imposed by a certain scientist and economist logic, so it seems that one can not do anything to oppose it.

Nothing to do, then, with the goodness of technology and human progress. It is, rather, an ideology more or less creeping which reduces the noble scope of anthropology and enslaves men, even those who do not follow it.

The answer to this unhealthy, harmful and dehumanizing paradigm is to acquire a sound anthropology lived in practice, both personal and commonal.

But what is this anthropology?

The Pope's answer can only be biblical-theological. It is the biblical man, made in the image and likeness of God—of which we have said in the first part of this chapter—and therefore able to take care of all creation doing so in memory of God's lordship in our world, the explicit proposal of the encyclical.

This means taking an anthropological mentality in which the man ceases to be thought of at the center of the earth, in obedience to one obsolete anthropocentric and pyramid-type scheme, to understand themselves as serving the animals, plants, earth, mountains, the stars.

It means, for many people, to transit from a decidedly anthropocentric perspective to a perspective in which much space to otherness both of things and of people is given. A sort of Copernican revolution.

The intake of this anthropology, again, involves personal and commonly effort to find ways, times, places where we can make true this anthropological style. Here then is a duty to experiment, not to rest and adapt at all costs to pre-existing, pre-constructed models, which did not give a good account of themselves.

It is the invitation to be creative both as individuals and as a community. It is an invitation to find new paths realistically. The moral commitment to guard the common home entails a serious intellectual and existential investment, with the assumption of the duty of risk that is inherent in this investment.

Yet Benedict XVI, during the well-known global economic crisis started in 2007, had spoken of the need to escape from the logic of a capitalist economy. Now Francis raises the same issue, not only for the economy but also for the ecology and for every moral aspect of human life.

Everything is connected and everything is held together!

But if you do not have ability to dare, starting from the intellectual reflection, and more or less fatalistic stereotypes are repeated, we are already dead while biologically still alive.

A clear example of how technology can be in the community and, sometimes, can awaken that sense of common home and community that contemporary cities frequently forget, is easily traceable in some experiences of sharing services, which smart cities often put in place in the intelligent management of urban functions.

The process of sharing of municipal services is made possible through tools such as open data, cloud computing, Internet of Thing and Apps that manage to reach the city and use it as a receptive sensor or as provider/user of services, taking the concept of prosumer (producer/consumer) fairly well known in the energy sector.

It is a concept of the city, this one, that best highlights what is called "human heritage", referring to the social and participatory aspect as a new way to plan urban facilities as well as to implement a cooperation between public and private actors in urban planning.

According to this line of thought, ICT become a means of providing services, and increase the quality of life of citizens without necessarily lead to the development of a hyper-technological city.

Share a ride through the sharing mobility is today, for example, a concrete possibility offered through web-platforms to the citizens of the smart city.

Another example is given by applications that relate to the social inclusion of disadvantaged groups, being this one known as a factor of livability of a city. One of the great achievements of the digital era, in fact, is that it is "horizontal," and can then easily reach all citizens, without any distinction. This leads, for example, to applications which contribute to overcome some limits such as in cities the use of urban infrastructures by disabled persons.

Finally it would be interesting to imagine the smart city as a functional city not only for men and women, but also for animals and plants in a holistic-integrated vision in which everything is connected. This eventually would allow overcoming an anthropocentric mindset towards a clear ecological dimension.

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