Chapter 3
Smart Cities: Case Studies

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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,

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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]

[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.

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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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