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Smart Cities and Smart Communities from an urban-technological perspective

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ABSTRACT

Nell'ultimo decennio il termine "smart city" sta diventando più familiare per tante persone. Tuttavia, è un concetto da osservare con maggiore attenzione per poter essere utilizzato correttamente. Raggiungere un livello di intelligenza dei cittadini implica lavorare sostanzialmente su quattro pilastri: "smart living", "smart working ", "smart mobility" e "smart environment". Tutti questi concetti sono diversi fra loro, ma tendono ad allinearsi.

Questo progetto valuta la trasformazione di molte città in tutto il mondo e studia varie metodologie utili a raggiungere lo status di "città intelligente". Più in dettaglio, si vuole mostrare come i cittadini sono una parte fondamentale di questo sviluppo e come le loro iniziative, la partecipazione proattiva e il feedback costante, possono contribuire a intraprendere la strada giusta per la generazione di una comunità intelligente.

L'obiettivo di questo progetto sarà quello di analizzare le evoluzioni tecnologiche in ognuno dei pilastri menzionati in precedenza e il loro impatto diretto su una comunità che decide di implementarle. Una parte importante di questo lavoro consiste nell'approfondire il funzionamento e l'implementazione del progetto.

Alla fine si proverà a dare al lettore una visione a 360 gradi su concetti importanti di questa tesi come smart city, smart community e sulla loro suddivisione come comunità energetica.

INTRODUCTION

The ideal solution to a problem can be a simple, tried-and-tested approach, or it can emerge after countless attempts and bring forth something completely new.

The previous quote describes the beginning of a new smart way to live. Living in a smart environment means being able to simply and easily access to a stimulating, rich environment filled with opportunities. The design of this environment is focusing on 5 main factors, attempting to create smart living, smart mobility, smart working, smart environment and at the end of all it will finish creating smart people, all of them together at the end, in an implicit way are a smart community.

A city could have an abundances of definitions depending of the perspective, however, one of the simplest way to see it is understanding a city as the merger of multiples communities. Cities are in a transformation process, reinventing themselves overtime to advance their economic, social and technological performance and improve their competiveness to manage the ongoing urban changes.

Every city faces different problems regarding with their own “core”, meaning that not all of them suffer from the same diseases, therefore, the antidote to improve their performance in order to be efficient, should take in consideration the specific characteristics of each of them. Not all the citizens have the same culture, education system, belonging sense for their city, and other features that historically are part of the idiosyncrasy of each city or community. The new problems that every city have been facing during the last decades, create at the same time a chance to reinvent themselves and be more efficient.

Nowadays, each city is targeting to be sustainable, and in other to achieve it they must create the enabling factors, innovate their administration’s processes and their service towards the citizens.

The cities have been facing different challenges, from rapid growing population to high energy demand, and high standards of amenities in urban areas. In developed countries, challenges are due to declining birth rates, aging societies demanding better healthcare services, and deterioration of physical infrastructure such as buildings, roads, water supply and sewage systems, and power grid. Moreover, the environmental situation is something that is a global concern, increasing carbon dioxide emissions and frequent natural disasters are urgent issues.

A new world, new challenges, new ways and paths require something that reshape people’s life and maybe one accurate answer to solve this situation could be replying successful small smart communities, that can be a trend model for other ones around, and could have a snowball effect in a higher scale, transforming even cities or countries.

Thus, smart communities may be viewed as a template of how smart technologies-people can allow local systems to effectively harness these global forces and deploy the results in a positive generation of new opportunities, socially, politically, and economically.

A multi-stakeholder model, where in order to reach a level of success all parts should be involved. Therefore, the target of this paper is to analyses the different type of smart cities, smart communities in all their versions, how they work and are composed, their evolution over the time and extract a model with their main features, that could be a guide line for future communities. Finally, do a step into the particular case of energy communities and the technologies that are part of it.

Analyzing successful cases in detail, mainly in Italy, and extracting the technological development, features and processes, this paper will be a model of a community that is in the smartening process, in other words, becoming a smart community.

The structure of the thesis is done in a way that the lector is able to find in the first 3 chapters, the main concepts that the thesis will highlight (smart cities, smart communities and energy communities). The overall description of them and the features or alternatives definitions that each of them could have depending of the source that mentioned them.

The chapter two highlight the more common alternatives of smart communities, that are smart industries and smart neighborhoods, their definitions and the variables that each of them have internally.

The chapters 4 to 7 analyze more in detail the components of a smart community in general, their elements, objectives, successful factors, and the weaknesses and barriers that are possible to find in the conformation process.

The chapter 8 is the one to lead the project because shows, the streams or the methodology that could be adopted to follow the smartening process. The fact that shows 4 pillars of a smart community, at the same time is highlighting the fact that not all the cities decide to adopt the 4 of them in simultaneous, mainly because some cities choose to implement the one that could be more critic for their reality.

The chapter 9 is trying to sketch the draft of how a smart community should be created. Which are the main steps, the first initiatives, the financial support, the branch generation and how at the end all of it could fit together.

The chapter 10 would be maybe the most interesting for the lector because is the space where all the theory convert in specific cases and real examples of implemented technology in cities all around the world, trying to have special attention in Italy where the writer based his research. All the examples follow the logic of the pillars, and the order that they were mentioned in the chapter 8.

The chapter 11 is an isolated example of an Italian city that shows more in detail the technological approach of smartening, digging into the platform creation , devices used around the city, and big data analysis.

Lastly, the chapter 12 shows all the new urban technologies applied within the city. And the diversity of those that are already circulating in the market as solutions that can be implemented.

1. INTRODUCTION TO THE SMART CITIES

Following the metaphor of the funnel, and seeing the smart city as the cherry of the cake, or the final aim where all the developments and efforts should cross, it is necessary to give a complete description about what they really are.

Nowadays, is common to hear that a city is smart, however under which parameters are that defined is not something completely established.

A variety of definitions and suggested attributes are available on the subject of “smart cities.” It seems everyone has a different conclusion about what makes a city “smart” or the ways in which to take an existing (non-smart) city and transform it.

The United for Smart Sustainable Cities (U4SSC) initiative defines a smart city as “an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects.” This definition is similar to the one of the creation of the smart community just raising up the bar in the total scope. The way to achieve that level using the same source is “It serves as the global platform to advocate for public policy and to encourage the use of ICTs to facilitate and ease the transition to smart sustainable cities.”

Given this broad topic, there is a necessity for this international support that proposes to take action where there are gaps and needs present. Additionally, the U4SSC provides a list of key performance indicators (KPIs) as a method to measure sustainability and ‘smartness’ and also compare cities among each other. The summary of this KPI’s are split into the categories of each sector, having different from transportation, health, environmental and so on.

These KPIs are broken down into three main dimensions to then be broken into other subcategories and other subcategories, allowing a comprehensive checklist of elements to come to fruition. It is important for these Smart Cities to calibrate their success using this mechanism.

The four main dimensions are:

- Economy- working
- Environment
- Society and Culture- Living
- Transportation

Throughout the narrowing process, the U4SSC has also labeled some KPIs as “core” indicators. The ability to report on these core indicators is a requirement in being considered a smart city. On the other hand, “advanced” indicators imply added initiatives and technologies, aiding further progression in these information and communication technologies.

For the sake of simplicity in narrowing the smart city concept, the following analysis will focus first on the KPIs indicated as core measuring elements. The Economy dimension is divided into three sub-dimensions: ICTs, Productivity, and Infrastructure. Information and communication technologies encompasses first, the seemingly obvious: percentage of households with internet access, fixed wired broadband or wireless broadband subscriptions, and the percentage of households served by 3G and 4G. More ICT KPIs include smart water and electricity meters to better manage water shortages and understand the electricity consumption of the city’s inhabitants in real-time.

All smart cities should have a dynamic public transportation system that encourages its use through accurate schedules with real-time updates and a way of traffic monitoring, whether through cameras or in-road sensors.

When moving on to the Productivity sub-dimension, research and development (R&D) expenditure and a record of new patents are important measurements of innovation. However, productivity is also estimated through employment rates, both the rates of unemployment and youth unemployment. More interesting and demanding, is the important measurements in the Infrastructure sub-dimension. Some necessary smart city elements are, basic water supply, safe drinking water, a system to deal with water loss and wastewater collection. Additionally, they are required to have sanitation facilities and solid waste collection with limited amounts of electricity outages or electrical interruptions, meaning consistent access to electricity. These smart cities should offer both high and light capacity public transportation with long transit lines and a bicycle network.

In discussing Environmental KPIs, it is important to report measurements of air quality and amount of greenhouse gas emissions, drinking water quality and water/freshwater consumptions. Waste treatment also plays a role whether wastewater or solid waste. Quantification of EMF exposure, presence of natural parks and other “green areas,” along with the obvious energy consumption rates and renewable are also extremely relevant.

Afterwards, proceeding to the Society and Culture dimension, various calculations in education, health, and cultural expenditure are significant: student ICT access, school enrollment, degrees in higher education, and adult literacy, with life expectancy, maternal mortality rate, and number of physicians. Housing, social inclusion, and safety measurements include percentage of people living in inadequate housing, gender income equity, income distribution and poverty rates, voter registration, and deaths or economic

losses due to natural disasters. Additionally, participation in the fire and police services, violent crime rate, and traffic fatalities are all measurable as well. The above mentioned, completes the KPIs that are the mandatory computations in order to qualify a city as "smart."

Going on multiple different sources online is possible to find more definition about what a Smart city is. The paper will show different definitions to have a wider idea of the concept from different perspectives. Some of them are:

A smart city can be as well as a platform which fosters collective (local) intelligence of all affected stakeholders, like businesses, governments, universities and citizens, enabled by the use of technology [7]

The smart city debate is gradually evolving from hardware infrastructures and technology towards softer aspects like city management and innovation of administrative processes. Indeed, managing city innovation is challenging because of the radical changes to which cities are exposed, such as immigration, urbanization and environment, which requires the extensive involvement of local communities of users and citizens. [24]

Through the users' involvement, the process of innovation becomes collaborative; the technical, the social and the subjective issues are no more considered as disconnected but as interdependent. Thus, the Smart communities concept can be assumed as people centered; cities are not merely the source of data that are gathered and analyzed to monitor and control but the places where communities can co-create opportunities and leverage bottom-up innovation. [8]

Indeed, what can be highlight of the previous definitions is that the word smart in this context does not exist without certain technologies involved. Smart cities services are based on a centralized architecture, where an abundance of heterogeneous set of technologies and devices interacting together, start creating a smart environment place by default. A primary characteristic of this type of environment is an urban internet of things infrastructure, meaning that starts an integration of the infrastructure with the new types of communication system.

The first question that merge with the previous integration is about the type of communication that should be linked with the infrastructure, about the standards that already exist and about the installation protocols, in summary analyzing an implementation model of technologies for a Smart city.

The main references that pre-select the typology of technologies that are absolutely necessary to create this type of environment are the IETF standards. Although, in the Internet of things IoT domain many different standards are still struggling to be the reference one and the most adopted. The IEFTF are based on best internet practices, but

the main characteristic is that are widely spread out among the community, that as was written before is one of the main part of the smart city/community.

Imagine a smart city with a technological Urban IoTs, in fact, are designed to support the Smart City vision, which aims at exploiting the most advanced communication technologies to support added-value services for the administration of the city and for the citizens.

This technologies are growing everyday in the market and being more implemented, trying to follow a standardized program taking always advantage of some technologies that are exposing a huge boom in the last years.

Nonetheless, that devices and technologies are quite developed to try to achieve the vision of a smart city, it is not already a standard protocol of implementation.

For the enabling technologies, furthermore, have reached a level of maturity that allows for the practical realization of IoT solutions and services, starting from field trials (labs and co creating spaces normally inside the city project) that will hopefully help clear the uncertainty that still prevents a massive adoption of the IoT. The technologies that are going to be describe are Iot, specific devices technology and big data. A chapter apart will be dedicated to the technologies applied in the energy communities.

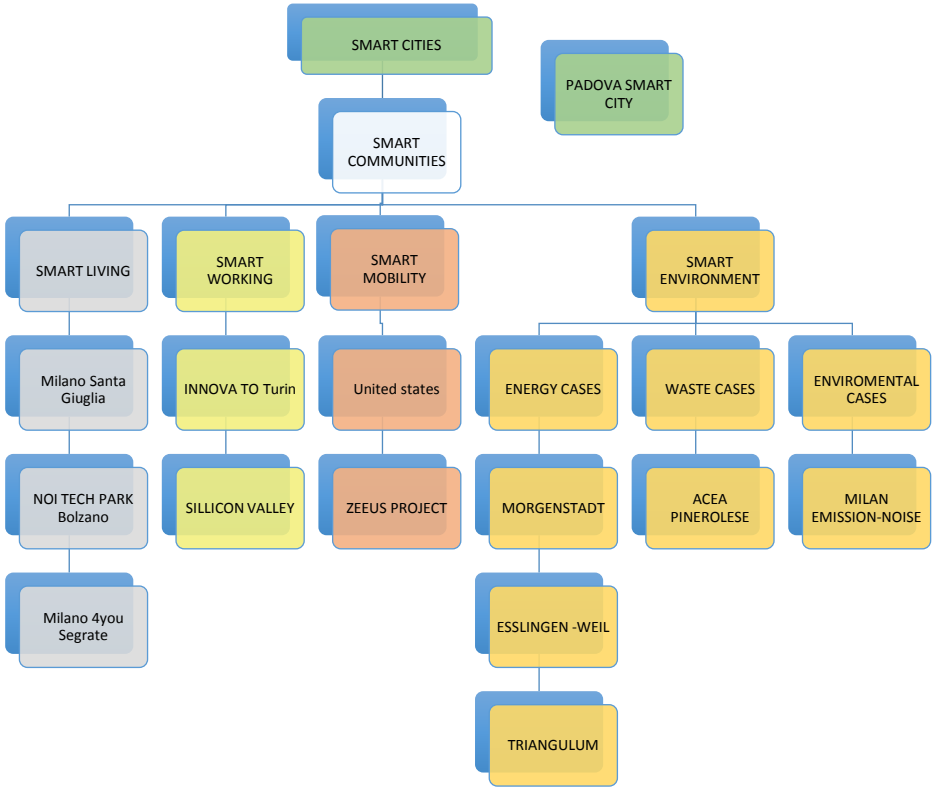


Figura 1: Paper overview description

2. INTRODUCTION TO THE SMART COMMUNITIES

"The technology of telecommunications and information and the economics of a global economy are rapidly converging, ushering in a post-industrial age of information. In the wake of this convergence, all institutions, both private and public, are being forced to reinvent themselves. Power is being realigned and wealth redefined. Old forms of governance are being replaced with the emergence of the City-State and the establishment of local and regional "smart communities" that aggressively embrace the tools of this new age". The previous quote was the first time that the expression Smart communities was mentioned in an international World Forum in 1997.

A concept that apparently is new, however have been around since 1997 when in a World Forum was mention the first time the concept of "Smart Communities". In that moment was estimated that some 50.000 cities and towns around the world would embrace "smart" initiatives by the year 2.000. In three years was supposed that governments and industry would start doing alliances to propel development. Cities and regions such as Singapore, Hong Kong, Yokohama, and San Diego (California) pioneers in the initiative started developing partnerships among industry, government, the private sector, health and educational institutions, and community groups. In that way, almost 22 years after, are some cities that are just adopting those challenges with a serious commitment. The key radical change will start when the Government, public services, private offer, and the citizens start getting aligned towards the same direction.

Meaning that it is an initiative towards the citizens but at the same time an initiative of themselves, to improve their own life, being a model that is fed with their own outcome. Although the emphasis is focus mainly on economic growth and competitiveness in the global knowledge-based economy, smart communities, by linking government, business, and citizens, are focusing on provide an opportunity for enhancing citizen participation in and influence over local decision making.

The process of involving and engaging a community towards a common goal, the smartening mechanism of turning over a simply individual based succeed, into a collective one. The new way of live, work and communicate, all of this is within the definition of smart community.

It's a lot of definitions about their meaning, and those are classified depending the perspective. This paper gathered all the possible perspectives around, in that way have an overall appreciation about what they are, and how should be built a smart community. Some of the definitions found are:

- General description

“Smart communities” (SCC) have the purpose of focusing on the development of a smart city that would include investments beyond pure ICT and that would especially put emphasis on the role of the human capital and people’s participation in the processes of administration and service delivery’s innovation. [19]

- Citizens role

People are not simply individuals but are considered in their potential as SCC that participate and contribute to improve the quality of living within a city The term SCC indicates a group of people, such as citizens, employees or students that collaborate to co-create economic and social value, support the decision making of the government or local authorities and leverage ICTs to accomplish common goals. In other words, SCC can also be defined as the ones that learn fast and well, in the sense that they make the highest and best use of intellectual, social, financial and instrumental resources. In the SCC concept, the human dimension is pin pointed as a crucial driver for the city’s development and management, making it fair, inclusive, efficient and sustainable

- Technology impact

ICT´s are, of course, important, but more as enabling technologies able to answer to social needs and facilitate the achievement of sustainable goals, while the human capital should be again at the centre . According to this point of view that is contrary to the first and well-established ideas that ICTs make cities automatically smarter, the smartness relies especially on the involvement and participation of the people [4]

- Coexisting Smart Communities SCC

Scholars generally refer to SCC as people that follow decision-making process of the Leading entity (could be the government or a leader), however couple of examples highlight that different SCC can coexist in the urban context. They may co-operate to leverage the collective intelligence of the city. They interact and empower each other to accomplish the community’s objectives while improving the quality of living in the city. this collaboration allowed to legitimate the project and aspired to advance the level of service offered to citizens. Second, usually scholars agree around the idea that ICTs enable the union of SCC , but the case study highlights that the rigidity of the context can affect this potential and transform ICT in an inhibiter. Thus, it opens the road to research on how to stimulate interactions and reactions to build the community when the rigidity of the context constrains the process and invisible walls isolate departments , otherwise the ICT potential remains unexploited. [16]

- Security and flux

A smart community consists of a collection of sensing devices, as well as the process control components of real-time data acquisition and monitoring, which gradually evolves from a closed isolated system to an open interactive system. There are four basic security

requirements of imminent communication for smart communities: data confidentiality, integrity, availability, and authenticity [15]

- E- governance

Some elements of answers have been put forward under the general rubric of e-governance. It suggests “a widespread adoption of a more community-based model of governance” with greater connectivity being facilitated by new technology. Aided by proximity, the application of NICT locally leads to economic, social, and political transformations encapsulated by the new smart community movement. [9]

- Network

The success of a locality is determined, in large part, by its effectiveness in gathering and using knowledge and technology. The ability to innovate and enhance technological performance depends on obtaining access to learning- intensive relations. Innovation stems from the interplay among the different institutions and individuals—firms, laboratories, universities, and consumers. The result is a society composed of more network-based governance patterns. [18]

- Internet

New technologies changed completely the way to see and understand life but if was one that have an incredible disruptive impact was Internet. Under the perspective of a smart community Internet represents a new way of engaging the public in government decision making, changing the very practice of politics in substantial ways. The Internet can facilitate the electronic democracy, enhancing citizens in all the participation process, not only political, just having an overall knowledge about every situation. A click that can figure out everything.

In terms of the citizenry of city, regions and broader political units, as a way to more direct forms of democratic engagement, facilitated by internet and NICT, reflects the human response to these new governance dynamics and the possibility that local forums of economic and civic activities can also give rise to political innovation

In this light, information technology (IT) is said to have the potential to fundamentally affect our ability as citizens to have a voice in shaping our future. [18]

- Geographic location

The notion of smart community refers to the locus in which such networked intelligence is embedded. A smart community is defined as a geographical area ranging in size from a neighborhood to a multicounty region within which citizens, organizations, and governing institutions deploy an NICT to transform their region in significant and fundamental ways. [10]

As was shown in the figure 1, smart communities could be divided in 2 main categories that are Smart Industries and Smart Neighborhoods. Inside this chapter will be useful to provide an explanation on what each of those are, because later on during the explanation of the cases of analysis will be useful to understand them.

2.1 Smart Industries

Usually, big industries are associated with monopolies and controllers in general of the regulation of the market where they bellow. Nevertheless, in the last years a lot of that models have been failing or experiencing lower incomes, mainly because costumers nowadays find different options for access to information and are less tighter to the corporate controls than some years ago, when the idea of a liberalization process for certain industries was just a dream.

Prosumers in the energy sector, car sharing in the transportation one, or the fact that employees can make a huge part of the innovation of the company starting with ideas from the bottom are certain facts that shown that a transformation process in this sectors/industries already started, and is the roadmap to succeed over the next years.

This type of communities that reorganized themselves and engaged all the users/employees/citizens in the development part of the process, following the sources are consider a type of smart communities, because can reinvent themselves through some changes.

2.2 Smart neighborhood

Focusing on the types of models that can be reply and can reach high efficient levels, with a lower theory implicit, and simply an efficient way to develop a cooperation between smaller communities, it's shown a model called smart neighborhood. This type of cooperation normally is in the context of energy reduction, different ways to be more eco-efficiency, and all the trends of concerning for the environment. Nonetheless, are not the only aims of concerns of this type of smaller communities. The sharing transportation models, working communities, the managing of the waste, are examples of concerns that need to be achieve and harnessing a higher bargaining capacity that a community have rather than as an individual approach, certain solution can arrive faster. Furthermore, following a simple theory of economies of scale as the number of users increase the overall cost can be divided and therefore is better to handle for part of each person, being a common benefit.

To highlight this context this paper will show the examples of 3 neighborhoods that work together as a society in a smart way, and cooperate to reach higher level of efficiency in different fields.

It's important to clarify that the examples chosen were in Italy due to the fact that is possible to get feasible information about those projects, and for further investigations will allow to go directly to see how those neighborhoods work.

The target is gather information and the main features of this societies and develop a model that can be a guide line and a manual of steps and procedures to how become a successful community.

The neighborhoods that are going to be analyzed are Bolzano Noitech park, Milano Santa Giulia, Smart city of Segrate. After in the paper using a different lens of analysis and digging deeper in the technologies applied, will be analyzed as an specific case PADOVA SMART CITY. [2,5,6,25]

3. INTRODUCTION TO ENERGY COMMUNITIES

One of the main features that have in common all the smart cities, is that all of them approach the energy in an efficient way. Due to this, it is necessary to establish different models that are further away of the traditional ones, in terms of centralized governance and technology applicable. The energy infrastructure is likely the single most important feature in any smart city model. It is an important feature because if this one hypothetically suffer certain outage for a long period of time, a lot of the other functions could fail. The new model involves a word that nowadays it is common to hear, this one is smart grid.

A smart grid has three main functions.

- Remote monitoring and control over microgrids and the modernization of power systems through self healing designs
- The fact that the number of customers are smaller and more geographically nearby, helps to create a culture between them and a constant information about the energy consumption and the respectively the cost of it.
- Lastly, it provides safe, secure and reliable integration of distributed and renewable energy resources. All these add up to an energy infrastructure that is more reliable, more sustainable and more resilient. Thus, a smart grid sits at the heart of the smart city, which cannot fully exist without it.

In summary, the concept of Smart Grid, can be defined as a “smart” electric power distribution network that exploits ICT to optimize electric power generation and distribution systems. Those allows a more efficient adjustment of power distribution to energy demand.

Certain measures such as Distributed Energy Resource (DER), Distributed Generation (DG), Demand Response (DR), Electric Mobility and Electric Vehicles (EV), Smart Meter (SM—an electronic measuring system that records electric energy consumption), Smart Home/Smart House, and some others are new variables in the energy consumption. Energy finishes being an aspect of home life that is often overlooked, and energy consumption increased at a higher rate than the population growth, are the main new changes in since the perspective of the energy point of view.

Apart of the smart grids, the micro grids are systems that firstly can work in isolation, and those includes power units, but with absolutely the presence of the energy storage and interconnected loads that can operate both connected to the bulk power system.

Smart Grids lead to the emergence of Smart Cities, where urban performance depends not only on the city’s endowment of hard infrastructure, but also, and increasingly so, on

the availability and quality of knowledge communication and social infrastructure (intellectual and social capital).

Meaning that the presence of certain technology should be necessary to be part of this improvement, it is required that ICT and sensors are presence on this process, those are crucial to identifying and meeting social needs and environmental standards.

In this context, a more specific concept arises: Smart Building (SB), a new model of building which integrates renewable energy sources and an intelligent management system based either on economic or self-sufficiency strategies.

Smart Environment (SE) is defined as one that is able to acquire and apply knowledge about it is inhabitants and their physical surroundings to improve the performance of the environment. Smart environment technologies can be used in a variety of ways to improve energy efficiency: by analyzing electric power usage to identify trends and anomalies; by identifying correlation between human behavior and electric power consumption; and by automating environments to be more energy efficient.

Certain delays in the early adoption of this models are for the fact that this technologies are consider new trends, or innovative technologies with a high risk of failure, but in reality those have been in the market for a good period of time, as heterogeneous technologies but that join all of them together can create a type of system adaptable in a smart city. Significant levels of automation, communications and information technology are already being brought to bear on the electrical distribution systems of many utilities to improve reliability.

There is a clear movement toward driving more intelligence into substations and field equipment to make faster decisions on fault isolation, location and restoration, feeder reconfiguration, and voltage and reactive power management. At the same time, a growing penetration of renewable generation means new needs for managing adaptive protection equipment and extending related substation designs.

This type of projects increase significantly the participation of the residential, commercial and industrial sector focusing on the energy efficiency but at the same time on the conservation of it.

Home and building automation systems have become integral parts of this movement, which will continue to increase.

Advanced metering infrastructures, meter data management systems and advanced data analytics will gather, assess and formulate essential information to refine forecasting, determine load response and improve operational decision making.

This all links directly back to the concept of smart grids enabling smart cities, whose other functions are also continuing to evolve.

The technology base supporting a city's infrastructure, buildings, industry and consumers all continue to move toward more flexible, compatible, automated and intelligent platforms.

Some drivers and particular improvements that should be done in the smartening process of a city taking into account the energy point of view are:

- Acceleration of efficiency (energy intensity dropping 2%/yr.)
- Distributed generation and energy resources (DG & DERs), including energy storage & microgrids
- District energy systems
- Smart Grid
- New EPA regulations, such as for greenhouse gases
- Demand response (and 3rd-party aggregation of same)
- Combined heat & power (CHP), plus waste heat recovery
- The increasingly interstate and even trans-national nature of utilities (and contractors too, which leads to security concerns).

Talking more about the framework, one of the aims of this paper is to highlight how different integration could coexist, institutions, people, private and public sector can interact between them creating new ways of cooperation that bring welfare to all the parts. This section is dedicated on the energy sector, mainly highlighting energy communities. However, it's also really important to defined a perimeter of analysis that in this case will be Europe, due to the fact that for certain aspects they act as an important community with no boundaries regulations, and with a targets altogether.

The outlook for Europe in terms of energy supply is having an important transition due to the forecast for the coming decades the dependency on external energy supply of the European Union is expected to increase up to 56% in 2020.

The EU as an actor in the global energy game advocates stable and transparent regulatory rules for the production and trade of energy [22]. Meaning that its already create the perfect ground to harvest all the energy efficiency projects.

Afterwards, not just the European Union understood that this will be the successful direction, but also the parts inside them got the same message, that working together as a community could be the only way to go further and have a higher advantage than working in traditional models.

Inside the European Union community, the idea is to reply models of digital transformation and energy efficiency following successful cases. In three strategically important locations - London, Lisbon and Milan - the effectiveness of new technologies is demonstrated by means of improved urban mobility structures, increased energy efficiency of buildings and local pollution emission reductions. [1]

Sharing Cities is a project that is focused on a different perspective of a city as a transformation project that facilitates implementation of intelligent solutions in European cities with increasing speed and scope. The project aims to encourage civil society to actively participate in the transformation of their municipalities. Together, a more dynamic, livable, competitive, and resource-efficient city will be created.

The other edge of an energy community project and maybe the one that have a higher impact, it is the engaging of citizens and stakeholders in urban development, because creating the overall culture is a challenge for those who are leading the project.

New media and online-based participatory procedures offer great potential for sustainable urban development. However, digital channels such as social media, online petitions and new interactive forms of participation significantly amplify friction between citizens and policy makers. Management of online-based citizen communications requires a lot of human resources and often does not generated tangible benefits. On the contrary, in some cases these channels are dominated by the overwhelming minority that push a narrow agenda.

A range of approaches and instruments for the effective management of digital participation and citizen communication processes already exists. However, the is still lack of practical application support, simplified solutions and professional expertise, which would help municipalities to rise above the harsh reactive communication and exploit the full potential of digital media for participation.

Through the exchange of solutions, practices, experiences and results as well as the improvement of urban data and infrastructure management, the project co-creates an improved living environment while reducing energy costs.

Over the last years, important projects have been developed in cities searching for smarter approaches in an energy community. Some projects developed in Europe that have some of the characteristics are listed below:

- Morgenstadt project: Moderation of an innovation process for the identification of demand-driven innovations for piloting for the Federal Garden Show (+ Modellquartier) 2019. This case will be the explain in detail in the following chapters of cases of analysis. [27]
- TRIANGULUM: EU lighthouse project involving the cities of Eindhoven, Stavanger and Manchester for the parallel transformation of three urban areas to "smart districts". [14]
- SMARTER TOGETHER: EU lighthouse project involving the cities of Munich, Lyon and Vienna for the parallel transformation of three city urban areas to "smart districts"

- Smart Urban Services: piloting and testing of urban sensor networks in the inner cities of Reutlingen and Chemnitz to establish new urban service and control platforms
- Zukunftsschau München 2040+: Development of strategic future scenarios for the updating of integrated urban development in the city of Munich
- Funkkaserne-Süd München: Development of alternative sustainability scenarios and financing concepts for improved portfolio management for residential construction companies
- Rheinquartier Oberlahnstein: Development of an actor-based guiding concept as well as the resulting infrastructural and urban development requirements for the design and planning of a city center
- Urban Retail Hybrid 3.0: Development of an innovative and location-dependent concept for hybrid commercial real estate in the urban area with a focus on positive effects for the urban environment, e.g. energy, mobility, resources, economic activity
- Innovationsquartier IQ: Development of a prototypical innovation concept for social innovation along alternative measures for sustainable and efficient neighborhood operations
- Smart District BB: Moderation process to identify requirements and responsibilities of landowners, investors, municipalities and municipal enterprises for establishing a "smart district"

The idea of analyzing some of this cases will be find the core of the smart district plan and create a replicable smart neighborhood framework and an ICT architecture to connect and coordinate the different technologies.

The framework is going to include all the technology that nowadays is the core of this concept, therefore the concepts of smart home, smart lighting, mobility on demand, smart energy grids, home consumer electronics, digital communication will be engaged as a check list in the analyzed projects.

Apart from the framework and the replicable model, something that is even more important are the type of objectives that this type of projects achieve.

Could be possible that some of them have different targets so should be analyzed with different lenses and different approaches. The general objectives of a smart districts with the energy approach are:

- Leadership in innovation
- Future security
- Sustainability
- Practical relevance
- Public perception

- Networking
- Interdisciplinary and cross-sectoral work

Thus, trying to achieve those objectives, cities and neighborhood are transformed into Citylabs or the so called urban energy laboratories, where as a first step a lot of information is gathered and based on the findings of the analysis, concrete projects are conceptualized collectively with local stakeholders and developed as part of a strategic roadmap for the future urban development in the city.

Usually a successful model is the improvement of an old one that acts as a pioneer. One of the aims of this paper is to identify which model was used before to discuss the performance of it and find the way of measuring, and how accurate it could be.

The model of reference is the Morgenstadt model, the objective of it was to achieve a better understanding of urban systems through analysis of six pioneering cities (Tokyo, Copenhagen, New York, Singapore, Freiburg and Berlin). Based on the results, a "Morgenstadt model" describes the performance of a city in a range of important areas (such as climate protection, energy performance, utilization of ICTs, sustainable mobility, governance, etc.) [27]

Analyzing the structure of this model is notable that its split in 2 branches:

- Thematic fields of innovation. Mobility, energy, water, ICT, buildings, governance, and logistics.
- Cross cutting fields of innovation. These are smart city financing, urban governance & planning and digital business & service innovation.

This energy community will be all describe in detail in the cases of analysis chapter. However, before swithching to define more elements about smart communities, it is absolutely necessary to dig into what are the concepts of microgrids and self healing grids.

3.1 Microgrids

A lot of features are required to have a smart microgrid, however, in the smartening process of a city are absolutely necessary for certain aspects like enhancing reliability, ensuring local control and meeting local demand.

Microgrids are small power systems of several megawatts (MW) or less in scale with three primary characteristics: distributed generators with optional storage capacity, autonomous load centers, and the capability to operate interconnected with or "islanded" from a larger grids. Storage can be provided by batteries, super-capacitors, flywheels, or other sources.

The fact of being able to integrate the energy from renewable and include the reliability propel the creation of microgrids.

Because of their lower scale, they facilitate systematic, innovative, approaches to solve local as well as global energy needs.

Having certain independence from the grid can be so positive for the supplier, and for the customers as well, increasing the level of service for level of users.

In some aspects, microgrids can be significantly more complex. For example, they might include DC elements and inverters for conversion. They can also exert greater control over a wider variety of loads, and the connection with the grid can be flexible.

Talking about the times where the general grid gives a unreliable service, microgrids are able to enable uninterrupted operation. Another feature is that they can be autonomous, when are coordinated by automatic controls without people involved in the process.

This microgrids are the more common technology in small communities, campus, and neighborhoods. Many of those microgrids will draw their power from locally available and preferably renewable sources like wind power and photovoltaics. Microgrids can be almost entirely self-sustaining. In fact, they can produce as much energy as they consume and generate “zero net” carbon emissions.

Building a smart micro grid also fits well with hardening the grid and making it more resilient, all to mitigate the impacts of extreme weather events.

Hardening, for instance, might mean that substations in flood-prone areas should be optimized for location and design and construction standards against floods – especially for under-ground substations. The design standards for feeders should be improved to the level applied to higher voltage lines. Selective undergrounding for critical lines may be cost effective. New materials can make power poles sturdier and cables more resilient.

For reliability and resilience, smart grid technologies will help.

Moving from the traditional SCADA systems to sensor and automated control of the microgrid with the respectively implementation of the smart meters will give to the system richer data to monitoring the performance of the grid.

3.2 Self-Healing Grid

A self-healing is the type of grid that uses digital components and real-time communications technologies, that are installed throughout a grid to monitor the grid’s electrical characteristics at all times and constantly tune itself so that it operates at an optimum state.

This type of grid has the particularity of update itself respectively the weather and another variables that affect it.

Another main features is the short time of respond (seconds) against potential abnormalities. Technically avoid all the snowball effects because isolated the problem immediately avoiding bigger blackouts. Plus, reroutes energy transmissions for the grid so that services continue for all customers while the problem is physically repaired by line crews.

A self-healing smart grid can provide a number of benefits that lend to a more stable and efficient system. Three of its primary functions include

- Real-time monitoring and reaction, which allows the system to constantly tune itself to an optimal state
- Anticipation, which enables the system to automatically look for problems that could trigger larger disturbances
- Rapid isolation, which allows the system to isolate parts of the network that experience failure from the rest of the system to avoid the spread of disruption and enables a more rapid restoration.

As a result of these functions, a self-healing smart grid system is able to reduce power outages and minimize their length when they do occur. The smart grid is able to detect abnormal signals, make adaptive reconfigurations and isolate disturbances, eliminating or minimizing electrical disturbances during storms or other catastrophes. And, because the system is self-healing, it has an end-to-end resilience that detects and overrides human errors that result in some of the power outages.

The consumers at the same time enjoy of the self-healing benefits as well, because the grid offer the ability to measure how the consumers are using the power, by this way they can adjust to the demand and the prices and regulated their consume.

Ultimately, this variable rate will incentivize consumers to shift their heavy use of electricity to times of the day when demand is low and will contribute to a healthier environment by helping consumers better manage and more efficiently use energy.

In despite of all the advantages mentioned previously, it is not an easy transition from the traditional grid towards a self healing smart grid.

The ideal smart grid system consists of microgrids, which are small, mostly self-sufficient power systems, and a stronger, smarter high-voltage power grid, which serves as the backbone to the overall system.The replacement of all the analog technologies for digital devices or components, and the corresponding software is really difficult and requires a big level of investment.

4. ELEMENTS AND COMPONENTS OF SMART CITIES AND COMMUNITIES

After the previous descriptions of the three main topic that will be analyze in this paper, are certain elements that are necessary to highlight.

Basically, every Smart community has some parameters in common. To be more specific are three main process and three main forces.

The three processes are:

- The marketplace and the composition of private enterprise within a locality
- The state participation improving the performance of the public sector components and mechanisms
- Social movements and civic associations which are the network of civic engagement

In the other hand are the three main forces surrounding those mentioned before are:

- financial mechanisms—the injection of capital flows into new and existing ventures (private, public, or civic based)
- demographics—the composition of local populations by such factors as age and ethnicity
- distribution of wealth and the sharing of prosperity, as it is produced among the various segments of the population.

Thus, generally speaking, the main challenge for a smart community is to create a group of cooperation, where the private, public, and civic interests may be addressed in an integrative way towards a common objective.

The effectiveness of this new group will depend so much of the power of the forces in the three processes. The local set of financial mechanisms, locally rooted but globally connected, will determine what sorts of private and public investments are made into NICT (National Information and communication technology), and they also provide the lifeblood for innovation and entrepreneurs hip of both private and civic natures.

Finding a new way to govern a community through the technological benefits of the NICT will definitely extend the boundaries, and will create policies that are more inclusive and at the same time more selective. The ideal social learning requires a certain distribution of collective intelligence that is not easy to reach, but with time and with an organize model these smart communities have multiple improvements and benefits.

Therefore, a truly smart community will do a higher effort to solve the issues about access and education of the citizens and the rest of parts involved, to converge on the opportunities that those model bring. Smart communities will need to move beyond the

focus on economic development and develop a coherent and compelling vision that makes it clear how the new information networks are going to promote deeper engagement across local governance.

5. OBJECTIVES OF SMART CITIES AND COMMUNITIES

The main objectives in the smart community are the one that will lead the project since the beginning, implying that a wrong expectation with those will be reflected in an unsuccessful network.

To tackle in the main objectives of the SCC is necessary to underline the parameters that cannot be avoid in this process.

Are 3 of them that should be the objectives to achieve during the sketching stage, and those are:

- leverage existing physical infrastructure to increase Internet connectivity in underserved areas.
- create a network, hardware and software (people involved). This network should be measurable, and to do it, is necessary that the smart community idea feasible, affordability, tailored for the community topic, scalability to the main area.
- Increase the digital inclusion for people with less resources

6. BARRIERS OF THE SMART CITIES AND COMMUNITIES

As was mentioned before Smart communities was an initiative that started in 1997, and still nowadays are cities and communities that never took that step forward. The benefits are countless, that is the reason for it is necessary to check it out what are the main barriers that block a community to become smart. Multiple factors are part of the barriers, but are some of them that can be summarized in the next categories.

- Top-down strategy

One of the main process for the creation of a smart community is the participation of the State as the public figure, nonetheless, indeed, in unsuccessful initiative to transformation into a smart community, local governments are usually resistant to innovation processes, and public employees are discouraged by bureaucratic procedures.

An abundance of this type of initiatives normally show up as a Top-down strategy, where are the governors or the private investors who decides to start certain innovation project. In multiple occasions merge the problem of lack of reliable information about the real situation of the citizens. Thus, the phenomenon of bottom-up innovation in public administrations remains understudied, and the innovation process itself is usually considered as a black box, which needs to be opened and studied in order to understand the main enablers and inhibiters of its implementation. A lot of this initiatives in order to be successful follow a logic bottom-up instead of a top-down strategy.

Therefore, the question of whether it´s possible to building practice an SCC of innovators inside a local government is still without an answer. Conversely, it is of crucial importance, because the combination of top-down and bottom-up approaches could have a synergistic effect on the innovation capacity of the city and can reinforce its smartness, owing to a two-direction circulation of knowledge and collaboration with stakeholders [19]

Even if civil servants can be unprepared for this bottom-up approach, co-operation between public sectors, enterprises, universities and citizens should be preferred instead of individualism because improvements and changes come especially from people who use and live the city [12]

- Budget assignation and origin of the funds

This is a role than its not well described in the conformation of the Smart communities, and mainly should be an injection of capital from the Government and the private sector towards the direction that a common forum that includes a community engaged as the main judge of where are going those resources. Corruption and not transparency about the destination of the resources, lack of traceability from the citizens in respect to the budget, reduce the credibility towards the project.

- Missing plan

As a matter of fact, the smartening process has been interpreted as a strategy to enhance both sustainability and performances of cities, but the development of a systemic vision is challenged by several factors, such as a short-term and unclear vision, a lack of political leadership, the lack of stakeholders' coordination and lack of a clear plan [19]

- SENSEMAKING, phases, and public government and employees.

The sense making process is characterized by three main phases, namely enactment, selection and retention. In the enactment phase, individuals realize that something is changing in the surrounding environment and in their flow of experience and identify the problem. In relation to local governments, even if the cities' competition may favor the birth of innovative ideas to make the public sector more efficient innovations remain circumscribed and do not propagate. Indeed, public administrations are change resistant, tricked with bureaucracy and risk averse, while innovation is risky and requires flexibility. In the selection phase, people rationalize the number of plausible interpretations identify structural and agency factors that make local governments innovation resilient. [19]

The elevated level of bureaucracy makes the public context highly formalized, while innovation requires dynamism to spread; the lack of finance and cultural resistance hinder the adoption of new procedures and discourages the promotion of innovation from the inside and finally, innovation is considered a "no-one's job" in the public administration and rarely departments have a person in charge of innovation). Even when it occurs, radical innovations cut across departments' boundaries, while high invisible walls still isolate them and prevent the coalescence of a smart community of innovators. Agency barriers are linked to the characteristics of individuals involved in the innovation process: people attracted to work in a bureaucratic environment tend to be less creative and risk averse and are discouraged by an environment that dissuades risk taking and overweighs and amplifies even small failures; moreover, public employees have a conservative attitude and nurture a certain resistance to change the way in which they have worked for years . Finally, at the retention phase, the outcomes of the process are evaluated, elaborated and organized to interpreter what happened. [19]

In local governments, innovation is usually initiated as a top-down process, with changes in governance and regulations enacted by managers and policy makers, and even if co-participation with citizens seems a firming paradigm, rarely bottom-up processes are originated by employees. On the contrary, the literature has acknowledged the value of involving employees in the innovation process, because they better known everyday difficulties, communicate with the final users and understand their wants. Thus, employees can be more than just single workers but a smart community of people who join their creativity, experience and problem-solving skills and drive innovation in the public administration. However, even if employees have a better understanding of the

problems of their work, seldom they are asked to become a smart community and think about how to improve their work. When they are asked so, the innovation path is not straightforward. [13]

- Longitudinal with the problem, longitudinal with the solution.

This barrier will be shown after in the paper where is evaluated the cases of the smart working, however it is necessary to anticipate why it was not successful when was implemented. “As somebody said, Innova.TO lets ideas come up. But now we need Realizza.TO to make smart communities happen”. The previous quote will be an advance of an example project of smart community developed in Turin about Innova.To, however the point of this quote as a barrier is mentioned that many of the initiatives get lost in the middle of the way because they do not have a plan of the implementation of the results that are going to be adapted.

- Cyber- physical system

A smart community is a collection of interdependent human-cyber-physical systems, in which the states of these systems are estimated and adapted by IoT technology. It enables sustainable societies that can offer increased well-being, safety, and security.

For example, the position and speed of vehicles can be collected at roadside units to improve highway traffic management. In addition, new healthcare services can be provided to the elderly with wearable health monitoring devices that report their physical states to remote healthcare professionals. Moreover, distributed optimal micro grid control for neighborhoods can be realized by coordinating residential solar panels, battery storage, and chargers for plug-in electric vehicles.

The connections in these networks can be achieved by wired communications technologies (power line communications or Ethernet) or wireless communications technologies (WiFi, Bluetooth, or Zigbee). These networks are connected to the outside world through the home gateway. In the upper level, the gateways at the lower level are interconnected by wide area networks or mobile telecommunication networks so that different sites can exchange information. All those developments require a back plan for the Internet security, because all the city could be run under data information.

- Paradox Internationalization vs national disintegration.

Process of international integration is paralleled by one of national disintegration: Subnational units are forced to adapt to their specific environments and have demonstrated the greatest adaptive capacities in this turbulent environment.

Always is that dilemma of implementing an international model in a different culture and citizens that have a different demeanor and behavior could be risky. Internationally, there is a flourishing of literature on systems of innovation from a local perspective. Terms such

as industrial and technology clusters, local industrial systems, and local systems of innovation have been used to denote subnational entities, their patterns of coordination and learning, and their main determinants of socio economic development. In the examples that are going to be highlight below, one of the main disclosures is that local models that take into account citizens idiosyncrasy are incredibly successful, and the idea of implementation of international ones is not an idea that roll with a lot of popularity.

- Hidden part of the iceberg

Using the metaphor than building a new smart community is similar to seeing an iceberg, when the upper part is all the technology involved in the process and the different types of alliances than are required to go ahead among the government and the communities, nonetheless is an important part that's the hidden portion of the iceberg that is under the water and tougher to analyze, but basically is the base of the creation, and this is the collective intelligence and the social learning that are completely necessary to move on in this process of creating a successful smart community.

Consequently, it is not sufficient to underline the importance of proximity and information technologies, which are indeed as necessary in this context as water in the preparation of a cup of tea but are clearly not sufficient to generate the desired outcome, that is, a cup of restorative tea or a truly smart community.

- Social transformation

The core transformational challenge may lie in the capacity to ignite and sustain social learning through an effective use of collective intelligence.

This in turn requires governance structures that ensure effective coordination among the different stake holders in this world where knowledge and power are distributed. And there is no way to do this job without a distributed governance structure, the only sort of governance capable of such cognitive mobilization

- Excess of government control

A useful role for the federal government is a limited one, meaning that the freedom and willing of exploring of the citizens is something that will provide best results. Provide the framework for connectedness and a wider deployment of NICT is a source of merit in the Smart Communities initiative that can quickly be quashed by overarching federal.

Adding so much control through certain mechanisms that add rigidities to the local natural development, can increase the resilience of the citizens rather than propel the desire to move forward.

7. SUCCESS FACTORS OF SMART CITIES AND COMMUNITIES

The successful factors to create a Smart community depend of the sketching stage where all the bases are settled and basically since the biases one it is understandable the direction of the SCC project.

One of the main aspects is to be close geographic because that allow to identify which are the common infrastructure like street lamps, utility poles and phone booths, that will create a higher use of the resources already existing.

Reading some of successful examples of Smart communities is observable that some common factors in all of them are:

- Overall impact in all tiers and multisector of the community.
- Social Learning and Collective Intelligence
- Transformation of mindset
- Involving all the player towards a same objective

8. PILLARS OF SMART CITIES AND COMMUNITIES

Planning a sustainable city means designing it from a 360° perspective: imagining private and public spaces able to promote and support social life; designing an urban fabric both in terms of strategic energy use and so that it can encourage virtuous lifestyles; establishing a development process that can promote long-term economic growth in the region.

The same concepts are reply in this case as: simplicity, efficiency, smartness and sustainability.

The concept of smart is develop targeting 4 main aspects:

- Smart living
- Smart Mobility
- Smart working
- Smart Environmental.

8.1 Smart Living

The concept of smart living is bound to the concept of smart building, and even if they are similar, smart living is a wider concept. Technologies such as, wireless monitoring of infrastructures; building integrated photovoltaic as a replacement of traditional construction materials; designer mobile homes; a, waste-to-energy technology and the market's most strict green certification of buildings, are in the package of what involves smart living. Create a life style more efficient, more controllable, more economical and sustainable, it is the main umbrella where smart living is develop. This new trend create a new life style but at the same time open a big door for new players in the market to enter with new disruptive solutions that can stop the way of how life is seen till now. Some of them are:

New technological construction tools such as Building Information Modelling (BIM) and virtualization are becoming really common; evolving building and architectural concepts being mobile homes, energy efficiency, retrofitting, pre-fabricated homes, flexible floor plants, convergence of IT with infrastructure, are just a few examples of new technologies.

The human presence for monitoring structures apparently is not necessary anymore, because the solution of wireless monitoring of infrastructures focused in the construction industry. The technology involves connected sensors attached to the buildings and infrastructures to be monitored. Those sensors can be plugged to a central node, and the node then communicates with a gateway which receives, stores and sends all the information coming from the nodes to a central data repository. Clients can then access the data through a free software application and monitor the status of their

infrastructures. This technology can be used for very diverse applications and types of construction.

A different concept of having a unique house structure could be just something of the past with the new concept of a mobile home with a design approach. This solution developed by designers is a high quality modular home that can be placed in virtually any location, including marinas. The house is configurable, modular and can be moved as many times as desired.

Some many companies start their participation of the market of waste-to-energy solution involves using natural light to grow algae in closed cultivation tanks placed on buildings roofs or facades. The innovative technology includes a set of systems and techniques to produce energy by treating wastewater with micro-algae cultures, and then converting those in biomass.

Building Integrated Photovoltaics (BIPV) provides a replacement of traditional building materials, with the benefit of allowing a building to generate their own energy. BIPVs also cost the same as traditional materials, however with added benefits. This is a fast growing segment of the solar power market. Photovoltaic cells can be directly integrated to the external structure of a building in elements such as walls, roofs and glass. Another implementation are:

- Free wireless connectivity in several public areas of the neighborhood.
- Interactive public spaces with multimedia installations.
- Fixed open data stations where information about the district can be sourced.
- Residential buildings designed to include communal areas, gyms, rooms for meetings/parties, catering and laundry services, to facilitate interaction and exchange between apartment blocks and develop a sense of community.

8.2 Smart Mobility

In the last years a widespread trend that is reshaping the public transportation industry. Air quality is a big concern in many urban environments. It is a phenomenon that has direct implications for the health and quality of life of people.

According to a report by the World Health Organization, air pollution is one of the leading causes of death in Europe. Tailpipe emissions from internal combustion engines are one of the major sources of harmful pollutants such as nitrogen oxides (created when combustion of fuels occur – particularly for diesel vehicles) and particulates.

Major cities are then forced to find ways to improve air quality and reduce CO_2 emissions. Looking at the whole world, we can see heterogeneous situations: China has been pushing

in this area for several years, while in Europe, public awareness of urban air quality issues has increased as a result of the Volkswagen diesel emissions scandal in September 2015.

Influenced by national energy policies and more driven by environmental and societal requirements than by commercial considerations, low- and zero-emissions transport systems are increasingly favoured, triggering significant developments in the deployment of electric buses in recent years.

Another factor that pushes for the adoption of “green” solutions for public transport is the political instability in major oil producing countries, which has intensified the instability in crude oil prices. As a result, the transit agencies around the globe are increasing the number of new electric vehicles.

The reduction of the emissions of greenhouse gases, and the efficiency in transportation could be one of the main topics of discussion regarding of the environmental solution and it is when many companies start developing technologies that make transportation friendlier with the planet.

Cities flipped over to transportation sharing models, bike and scooter mobility, care sharing, but mainly into all the types of electric vehicles solutions.

Nonetheless, there is still a part of the market that took longer to be seen as an opportunity to invest and a quicker way to achieve environmental goals: public transportation.

Commonly, public transportation is a segment that is managed by State-owned enterprises. Pubic regulations, budgets and hierarchical decisions postponed the growth of this industry till the last decade.

Some solution have been showing up during the last decade, some of them are listed below:

8.2.1 Charging technologies for Public Transportation

The charging solutions for electric vehicles have been improving, the current technologies on the market are mainly 4 types:

- Plug-in solutions
- Battery swap
- Pantograph charging
- OLEV solution.

Plug-in solution are the typical solutions that consists in a re-charge of battery through a physical connection with a charging station. Most diffused have a charging power around 50-60 kW and permit a re-charge of battery that is quite long (3-4 hours) but healthier for the useful life of the battery installed. If a vehicle has only a plug-in system as recharge

system, usually the dimension of the battery installed is quite high to permit a charging cycle enough to complete an entire day of work/ series of lines.

Battery swap is a rare solution because is costly in terms of investment and logistic. It works substituting physically the battery with a recharged one, permitting to a bus to have a quite infinite work cycle. The substitution succeeds in few minutes and the exhaust battery is recharged inside the same station.

Pantograph charging solutions are quite famous nowadays. They permit a very fast recharge of the battery with a huge power of recharge (150 – 450 kW). This recharge is obtained in few minutes, with possibilities to have fast recharge of some seconds. Contact bars are usually installed on the roof of the vehicle and they keep in touch with the systems that can be installed directly on the bus station, permitting the recharge along the line.

OLEV solutions are, as Battery swap, rarely applied. They permit a recharge of the battery with a wireless system during the normal work, thanks to low frequency systems posed directly below the road surface. The cost of these system is very high and require a huge investment also in terms of infrastructures.

The rapidity in recharge is something very important to have an affirmation of electric buses as credible competitors of normal solutions. But normally the systems that permit a faster recharge have a higher cost and have to be put together with low power systems of recharge, to permit during the night a slower charge very important for the cell balancing of the battery pack and to increase the battery lifetime.

8.2.2 Electric charging cars

Aside from the section which discussed the charging and methodologies in regards to electric buses, smart mobility is a concept that applies to private vehicles also. This type of charging is better known as B to X. The charging system functions when the machine is connected directly to a current, or “plugged-in.” Connecting directly to the battery management system, or BMS, program allows electricity to be injected or withdrawn at any moment. However, the batteries of these machines suffer in the span of their life cycle as they are “plugged-in” 95% of the time while in parking stations. This chapter focuses on the main infrastructure and technologies that are necessary for this charging system. Additionally, the four main charging options for these electric vehicles are as follows:

- DUMB charging. This option has basic functionality, leaving no room for programming the charging in any way.
- Delayed charging. In this charging option, the user can charge the car at a certain point. It still features more basic functionality, however, charging can be scheduled.

- Price-based charging. This may be the most advanced system. It requires connection between the BMS program and the grid, charging the vehicle when prices of electricity are lower.
- Load-based charging. The algorithm utilizes the available renewable dispatch program in order to program the charging system.

Additionally to the previous comments mentioned, it is important to note that the majority of the project of B to X are based on exchanging DC current between the grid and the electric cars. This implies that the moment the vehicle is plugged-in, the energy travels directly into the battery of the car, without passing through its internal charger. Nowadays, new projects, such as Renault in Amsterdam, have been using the AC type of current, in which the charger is within the vehicle and the charging posts are considered simple transmitters of current.

One of the main challenges presented in these charging technologies is the long estimated charging times. Big players in the market, such as BMW and Volkswagen, have been working to provide charging stations that run with a current of 350 kilo-Watts and will charge vehicles, without affecting the battery performance, in as little at 15 to 30 minutes. An additional technology is in the works to be developed, in comparison to the DC current. Analog charging is similar to the dynamic of 'plug-in' charging, however, the cord will be attached to an electrically controlled device which will guarantee better security of the operation.

8.2.3 Vehicles to grid

V2G is a system in which PEV (plug-in electric vehicles) exchange power and information plugging to the grid in a bi-directional way, either absorbing energy to recharge the vehicle battery or injecting energy into the electric grid.

It is the service that can transform an electric car into a wheeled battery, allowing the owner to sell an energy service through his car, with benefits for the whole society.

The owner of a V2G vehicle can contribute to the national grid stability, empower the exploitation of renewable, and drive with zero emissions in the city.

The battery car is connected to the grid through a V2G unit which consists of an AC/DC bi-directional inverter and a control unit, in order to guarantee a measurable, controlled and bi-directional flow of energy and information.

The electricity flows from the grid to the car when the battery has to be charged, while it flows from the car to the grid for instance in case of load peak of demand or frequency balance.

The car becomes a movable battery which is charged at home during the night, and which supplies energy to your office during the day, a new shared resource for every energy user

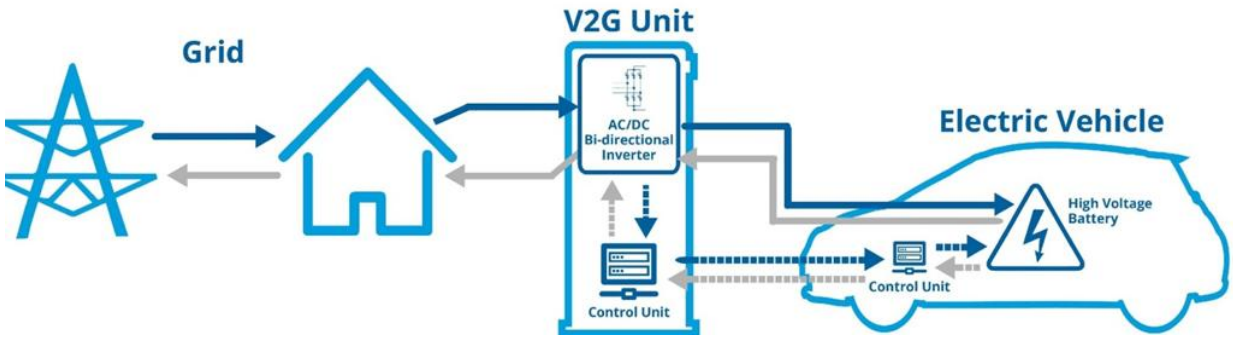


Figura 2: Description of V2G

The EVSE is the interface between the electric car and the grid, where the bidirectional flow of electricity and data occurs.

There are two types of charge: AC and DC.

Since the battery stores direct current, there are two different layout according to the current of charge:

- AC charging:
  - It needs an on board power inverter from AC to DC in order to charge the battery
  - the power management is shared between the EVSE and the CAR
  - lower power transfer capabilities
  - mostly used both for private and public facilities
  - easier way since input power is AC.
  - Cheaper

- DC charging:
  - it needs an inverter from DC to AC which is inside the EVSE, in order to inject to the grid the battery current
  - the power management is mainly guaranteed by the EVSE higher power transfer capabilities and speed (fast charge) more costly.

More characteristic about the V2G are:

- Provide to the grid ancillary services
- Control the loads
- Coordinate with the renewable energies
- Reactive power support

- Stabilize the grid for short periods

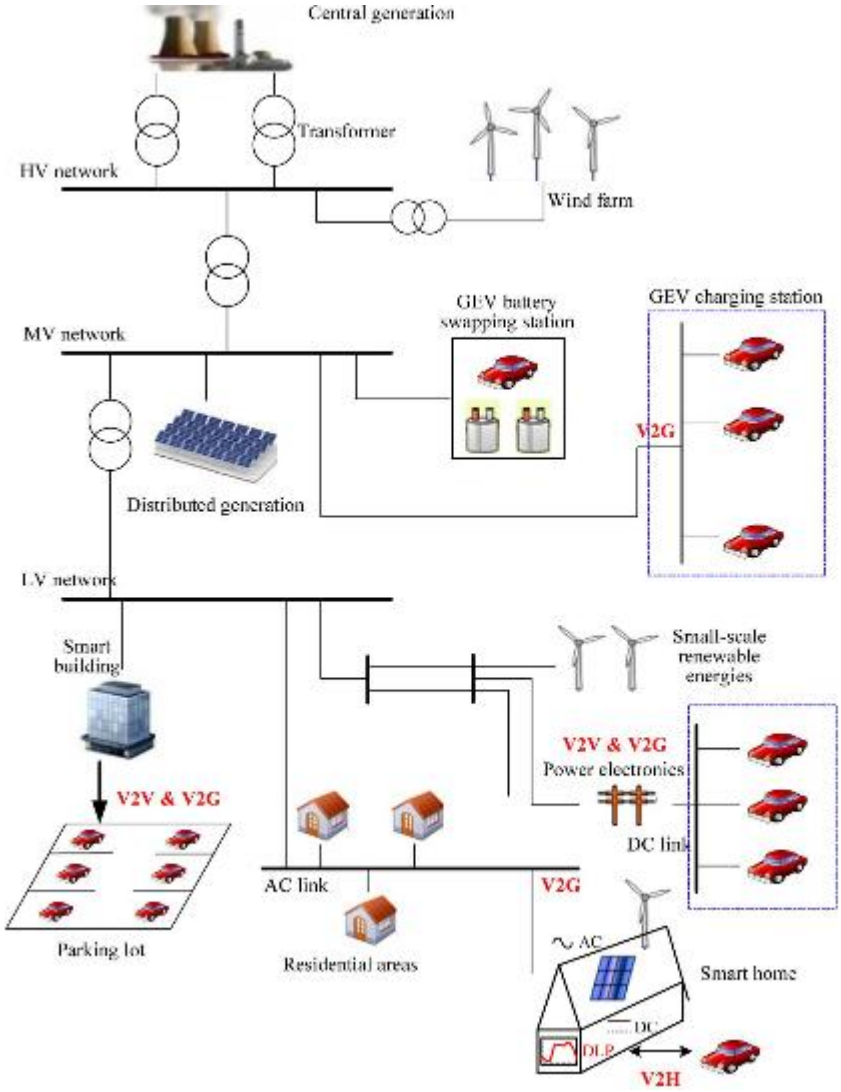
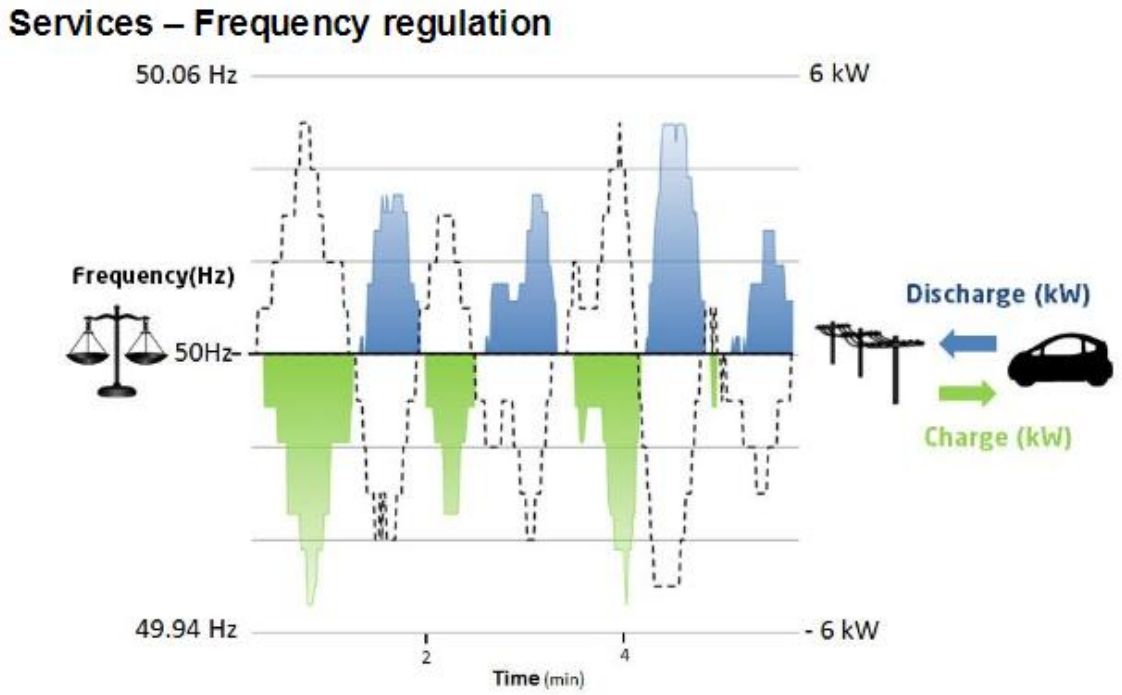


Figura 3: V2G framework

Maybe the most well known case of V2G as a hub already implemented is in Denmark, where the total V2G hub have a capacity of 100 Kw. The fact of that storage capacity exist propel the development of small renewable plants around the area. The possibility to inject and withdraw energy from the grid at any time generate an positive impact in the balancing energy loads. At the end, the storage is necessary for the energy surplus during the production from the renewable.

The next figure will show the range of the frequency regulation in the grid with the V2G where allow a model of dynamic operation points (multiple points to connect with the grid). At the same time implies relaxation periods for storage, based on the multiple providers, drivers of the V2G.



The concept of frequency regulation with V2G appears when an automatic generation control on the grid is not enough to balance the interaction between the demand and the supply. The V2G nowadays is seen as an option to active power support and put back the frequency to the normal levels as is shown in the figure above.

V2G are vehicles that are available for bulk power supply for a short term. This solution is a win-win situation for the drivers and TSO companies.

8.2.4 Vehicles to Home

Certain EVs, called gridable EVs (GEVs), a part of being a normal energy consumer drawing energy from the grid, are also able to inject energy back with a bidirectional charger.
The lower productivity of the traditional power plants (around 30%) compared with the renewable sources that is roughly 70%, is not necessary an advantage, because the intermittent sources such as the renewable affects the grid voltage, the frequency and another variables of the grid.
Therefore, the transmission operators should find ways to compensate and regulate the use of it. Under this hypothesis the GEV appear as a good player to compensate the grid.

Furthermore, a group of GEVs is also a good candidate to support the community-grid operation. Based on the charging/discharging capability of GEVs and the energy-efficient requirement of power grid, the vehicle-to-home (V2H), vehicle-to-vehicle (V2V), and vehicle-to-grid (V2G) concepts have become more and more attractive in recent years and probably will turn into reality in the near future.

Nowadays, the GEV are more a tool that help to distributed sources for the power grid than a simple mechanism of transport.
This paper takes an overview about this new technologies, mainly about V2G and V2H.

V2H shows that the GEV can be connected to a home grid for charging and/or discharging by the onboard or off board bidirectional charger. In this way the GEV following a scheme of control can draw the energy from the house or transfer it back.

Some of the main features of the V2H are:
It is a home back generator, and control of the loads. Cooperates with the domestically devices for the load shift, in the mean time, it is able to sell energy to the grid at peak time price and charge when it is off peak.

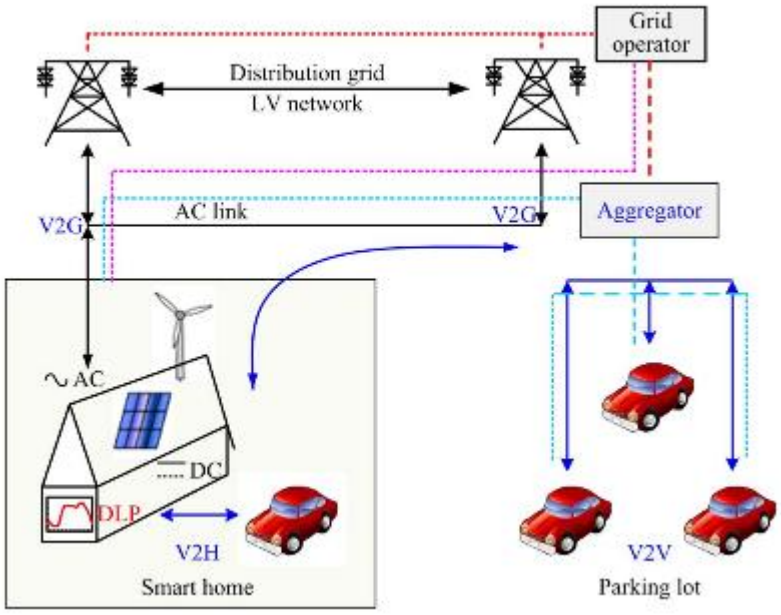


Figura 4: V2H framework

Another solutions have be adopted with this new trend such as:

- A smart district requires good internal mobility, good access to the outside, a network of ICT infrastructure, innovative and intelligent traffic management systems, sustainable and safe public transport and strategies to support the use of environmentally friendly vehicles.
- Smart car parks, with a guidance system and real time controlled access to the car park.
- car sharing and bike sharing system.
- Electric- hybrid vehicles, vehicles to grid, vehicles to home.

- Different types of batteries
- Digital internal traffic management with controlled access for vehicles.
- Expansion of public transport

8.3 Smart Working

Smart Working is the adaptation to different instruments, modernization of the layouts, setting up of home workstations and introduction of new regulations. However, the concept is still wider.

To estipulate a Smart working as a process that could be create, it is important to understood it as a six steps transitions:

- 1-2 Smart Index and Smart Readiness to determine when your business is ready
- 3-4 Smart Project and Smart Workshop to define the policy and bring the key resources onboard
- 5-6 Smart Training and Smart Impact to furnish the people with smart competencies and measure the impacts of the new work mode to decide whether and how to proceed.

Smart is not only technology. Smart does not only mean working from home, and it is not just changing work schedules. Smart is not a shared desk, but a new place of freedom and sharing of objectives which people choose in full awareness to improve their own satisfaction, mutually agreeing to identify the rules and instruments.

These are just some of the key words, important concepts, and useful indications to choose the smart working path.

In a constantly evolving workplace, to encourage competition and development, we need to create a working environment that can respond to the new demands. The main focus is in aspects such as: connection, practicality and efficiency, fresh workplace designs and new interactions with the region and the city.

Modern, comfortable and practical co-working areas in line with the most cutting-edge examples found in Europe.

Areas for encouraging young entrepreneurs and supporting the launch of creative and innovative start-ups, including partnerships between the public and private sectors

Public spaces for hire to organize private business networking events.

Support for the development of local artisanal and industrial production.

8.4 Smart Environment

Smart environment could be the widest pillar of the smartening process. Thus, it is necessary to split in two different streams where should be important to realize certain emphasis. The first branch is the Management Waste, and the last one it is relate to the

management of the energy resource. However, it is a pillar that have a overall coverage of the previous three, meaning that being smart in the living, mobility and working, surely, at the same time will have a positive impact on the environment.

Apart of certain solutions that can be mention below, the branch of management of energy have a deeper description on the case of analysis of the energy community.

For the waste side, Serious environmental degradation occurs due to open, uncontrolled and poorly managed waste dumping in many metropolitan cities of developing countries. Roughly 90% of the waste is disposed of in open dumping areas without any control of the waste and the possibilities of recycling. Recently developed countries have implemented the visionary concept of zero waste which is encouraging latest technologies of MSWM. While on the other hand in most developing countries waste management is a matter of least concern, which is causing severe environmental and health issues in those countries.

8.4.1 Waste Technologies

Regardless of it, some many technologies have been appearing in the last years. Some of them are:

- **Waste bin monitoring technology using Global System of Mobile (GSM)**

Mainly the technology more disruptive in this field, that reduce the number of times that the trucks should pass for the garbage. A combination of Zigbee technology and GSM is this technology where sensors are placed in public garbage bins to detect a certain optimum level of waste. When the garbage reaches the threshold level, indication will be transferred to the controller which will further give indication to driver of collection truck for emptying the bin urgently. The indication will be send to the driver through SMS using GSM.

- **Web based GIS (Geographic information system) technology**

Having the chance to follow all the waste cycle, since the production to the treatment plants allow the companies on charge to automate and optimize the whole chain, this make easier the separation, regulation and control. Over the last few years the GIS technology has gained popularity in almost every field of life. Coupling the GIS technology along with waste collecting became popular over the past few years in developed countries like Italy.

The evolution of Information and Communication technology (ICTs) has allowed the creation of efficient integrated systems which also capable to meet the requirements of the waste cycle. This solution of coupling the waste collection and the Web- GIS oriented systems has become increasingly used over the last years in Italy. The full traceability and certification of the various. [21]

- **Automated Sorting**

Modern sorting plants are converting to sensor based sorting systems to improve sorting efficiency. This technology had exempted the low technology or manual sorting options. This technology is beneficial because it has high recovery rate, low operation cost and high reorganization capability. This process can convert and useless garbage to highly useful product output, which can reduce carbon footprint and emissions [21]

- **Energy recovery**

The last step before disposal is energy recovery. All the waste residue after sorting, reuse, recycle and processing, is further inaugurated for energy recovery. Latest energy conversion technologies are categorize into two broad categories, including bioconversion and thermal conversion technologies. Waste to Energy (WTE) provides a renewable alternative of energy in the world, where we have limited fossil reservoirs.

- **Bio-conversion**

For possible energy recovery, currently food waste and other combustible waste are collectively incinerated and landfilled. However, the upper two techniques are facing more environmental and economic issues. Food waste can be used to produce biofuel through different fermentation processes. Currently, valorization is being used for the production of hydrogen, ethanol, biodiesel and biogas.

8.4.2 Energy technologies-solutions

Regarding to energy different technologies have been merging in the market, such as:

- **Efficient energy production by hybrid systems**

The first feature that the model tries to strength and the feature that cannot miss in an energy community model is what is called ENERGY HYBRID SYSTEM, due to the multitude of possible combinations, hybrid energy systems can deliver highly efficient solutions for energy generation and guarantee maximum performance.

This category of model requires the participation of energy providers, private companies, city administrations, households, mobility providers and mechanical engineering companies. Engaging all of them on the purpose of propel a sustainable energy source in the district/neighborhood or city.

The efficiency of this system is going to be measured by a highest efficiency in the energy generation, and this is going to be guaranteed by the combination of central and decentralized storage forms, intelligent and low-loss control of energy consumption can also be achieved.

Starting for the definition of the concept is just the joining of two or more different of energy sources, taking into account the reliability of the traditional one, and the

sustainability of the renewables sources, and in this way enabling innovative and energy-efficient solutions for cities, districts or individual households

The objective of such an energy supply network is to achieve a balance between production and consumption. To this end, the seamless integration of various technologies for generation, storage and consumption of energy, which offer new opportunities for innovative solutions, is necessary. When combining exclusively renewable sources of energy, such as solar or wind energy, hybrid energy systems can deliver 100% renewable energy with the added benefit of improved flexibly and ability to adapt to demand. Therefore, the model of an energy community requires a fully automatic hybrid energy system, that speaking more in detail mentioned the next elements:

- One Energy processing plant (traditional energy)
- Control energy system
- Short term energy storage unit
- A closed-loop system

The objective is to take advantage of the enormous potential of cities to store and utilize energy. Cities can use this potential to balance energy supply and demand in the local network. The project covers both electricity and heat generation and aims to integrate renewable energies through central and decentralized electrical storage as well as through bounding of decentralized generators and loads, enabled by additional thermal storage. The challenges for the future of the energy system is to achieve a spatio-temporal balance in the context of strongly fluctuating and dispersed renewable energy production and consumption. This type of projects of hybrid communities has certain fundamentals paths that are listed below.

- Energy storage
- Smart grids
- Controllable consumption
- Network capacity expansion
- Plannable production.

8.4.3 Energy storage solution

Without any doubts thinking in an energy community leaving outside the energy storage will be absolutely impossible to achieve. Lithium ion batteries are still the technology that is more advance, even if this is still considerate as expensive, but necessary for this type of projects

A small, decentralized battery-based lithium-ion batteries (approx. 1-20 kilowatts) are coupled to larger storage units of approx. 50 kilowatts to 5 megawatts (such as the redox

flow technology further developed by Fraunhofer) and in this way the photovoltaic (PV) systems could have a higher impact.

- **Sensors and Intelligent Networks**

Remote water supply can ensure water provision in arid areas. In order to use water more efficiently, water loss during transportation must be kept to zero. New software for leak detection or process simulations in the area of water system management can be used to optimize water supply. In addition, ever-evolving technologies can reduce the negative environmental impacts of water treatment.

The use of sensors or sensor networks can replace conventional water meters by not only recording data related to water consumption, water pressure and system performance, but also through feeding data directly into an intelligent network (smart grid). This allows for long-term measurement and forecasts about water consumption. Further sensors can also detect possible damage to pipelines, enabling repair at the earliest possible stage.

- **Controllable consumption**

Controllable consumption focuses mainly on decentralized heat pump systems with high-performance thermal storage.

Network capacity expansion: In terms of conventional network expansion, in addition to the cost-intensive high-voltage direct-current transmission, which is only relevant in the context of long-distance network delivery, regional network capacity expansion focuses on the better use of networks by intelligent regulation and storage.

Plannable production: It is facilitated through decentralized heat and power generation plants operated by means of high-capacity thermal storage tanks, which are used instead of conventional heaters.

All this application starts impacting in the lighting and the heating process of buildings and in transportation.

This type of innovative technologies, smart module systems generate their own energy (mainly solar) and are characterized by exceptionally high efficiency. Complemented by its socially added value, such interventions can significantly improve sustainability of public spaces.

9. BUILDING A SMART COMMUNITIES MODEL

The main target of this thesis paper is having the chance to analyze all the type of communities previously mentioned and find the main features of each of them, the common factors, how they are built, who takes the first initiatives, and based on all the information gathered from that create a model that in terms of "modus operandi" could be feasible to reply, and allow to establish certain parameters that are necessary in order to have a successful smart community. Therefore, the model is built following the next steps:

- Initiative
- Capital Investment (funding)
- Governance
- Creation of ecosystem
- Network
- Community
- Surviving

The next following steps are illustrated in the next figure

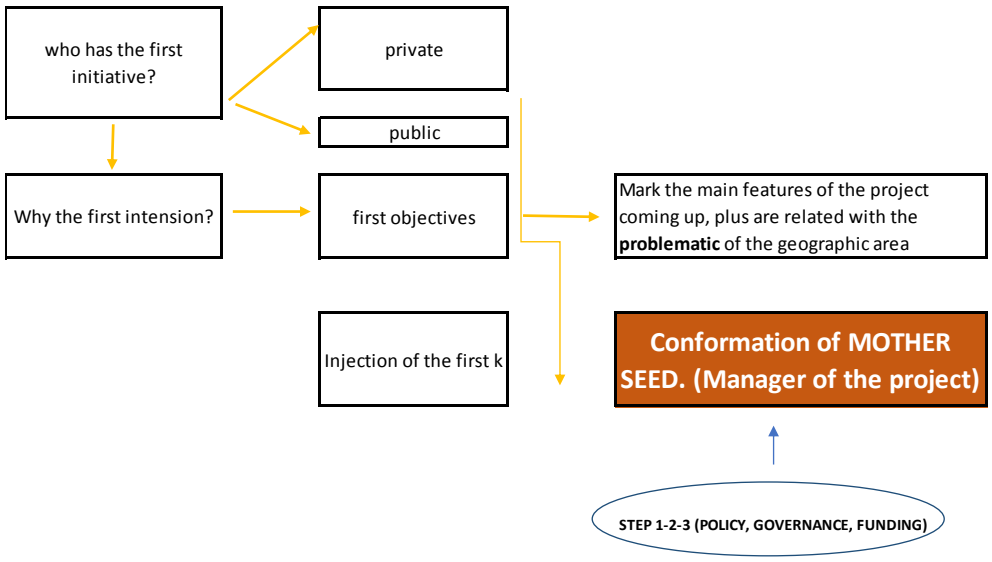
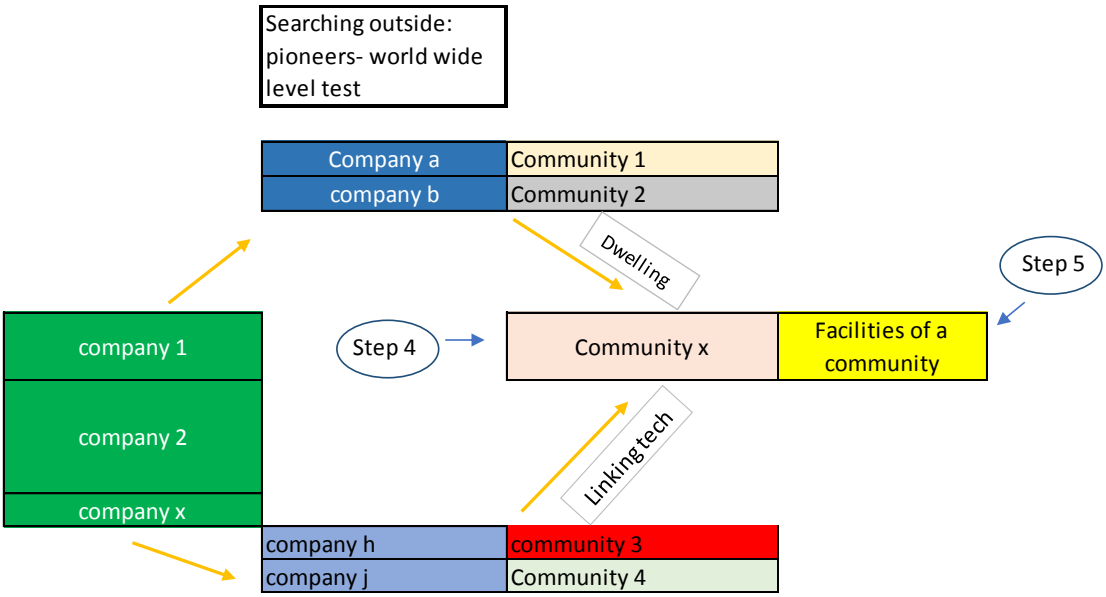


Figura 5: Sketching phase model



1 BRANCH: Ecosystem	2 BRANCH: NETWORK	3 BRANCH: COMMUNITY	4. BRANCH: SURVIVING
Normally, partners of the region, same targets, 1st investments, common problems	Different objetives, but all governed for the mother seed. Private investment, project inside the community, private revenues, share welfare	Sharing technology and people interaction, plus the facility of finding everything without the need of going out fro it create a community. Linked by technologies and convenience.	Being in a community implies, pulling towards the same side and ensure for the well general welfare

Figura 6: Modelling smart community

10. CASES OF ANALYSIS

The smartening process of a community or a city is more rather than a methodology that should be follow step for step, it is an internal identification process, where each community should evaluate the more urgent problematic, the radical changes that should be done in the short, medium and long term, the budget to do it, the culture of the citizens and some other variables that are inherent into the diversity of each of them. Then, every community that passed through this process with a successful transition, probably focus their effort in an specific field, instead of trying to reshape all the internal processes at the same time.

The cases of analysis that will be analyze during this paper have a focus on each of the pillars mentioned in the previous chapter.

10.1 Cases of Smart Living

For Smart living, this paper will analyze 3 main cases of Italian neighborhood that took the initiative to change their normal habits and the natural environment of a normal neighborhood, in a new vibe of communication and interaction between the citizens, engaging them in multiple dynamics and make them part of the transformation of their own life. Each case has particularities and different features that they adopted depending of their own idiosyncrasy.

10.1.1 Case Smart Living 1 (NOITECH Bolzano) [25]

Bolzano is a region located at the northern end of Upper Italy's broad plain, at the junction between Northern and Southern Europe, at the language boundary between German and Italian, in a mix of cultures and mentalities. This land full of contrast gives an opportunity to propel and take advantage of the diversity engaged in this region. This diversity that later on finished being the networking creating.

This region put all their efforts in renewable and alternatives energy sources such as hydroelectric and solar power, besides a wide range of companies in the agricultural businesses are trying to start initiatives in the food market.

That is why this region's inherent and acquired strengths also serve as the foundation supporting the pillars of South Tyrol's economy: tourism and Alpine technologies, agriculture and food production, alternative energy sources and climate technology. In all of these areas South Tyrol brings forth internationally renowned experts, technologies and innovations.

Therefore, the Government of the region started the initiative to create a network of start uppers, entrepreneurs, and researchers, but the main difference is providing them a place to develop their normal life.

Taking innovation as the main factor to success and joining public and private forces they are trying to achieve the aims.

The main companies that believed in this project and decided to create the network were:

- Eurac research
- Unibz Free University of Bolzano
- Laimburg
- Fraunhofer Italy
- Climate house agency CasaClima
- EURAC RESEARCH

The type of projects that this companies realize are like creating a State-of-the-art infrastructure, such as a simulator for all the Earth's climate zones and realistic mock-ups of building systems, enables researchers to predict how technology will develop in the future. The workers of NOI techpark are focusing in sustainable heating and cooling, photovoltaics and sustainable buildings, that are going to be part of the analysis in the technologies section of this thesis. In the NOI techpark they do two types of work, indoor labs and outdoors labs.

- Indoor labs
  - Multifunctional Facades Lab
  - Solare PV Lab
  - Accelerated Life Testing Lab
  - Heat Pumps Lab
  - Calibration Lab

- Outdoor Labs
  - PV Integration Lab
  - Façade System Interaction Lab
  - Energy Exchange Lab
  - UNIBZ

At the NOI Techpark, the Free University of Bozen-Bolzano is responsible for establishing those labs where business-relevant research is undertaken.

They are the main source of talent and skill new entrepreneurs with different capacities and different background comparing with another university, mainly because a lot of their thesis projects and external projects have higher emphasis in certain areas specific of the region.

This involves the setting up and expansion of technological research in Alpine technologies, ClimateHouse and energy production, as well as food technology. Research is conducted in the specific areas of agricultural mechanics, ClimateHouse, renewable

energy, food engineering, sensor technology, fluid mechanics, computer science and design.

Around 100 researchers and technicians from the university will work at the NOI Techpark between 2017 and 2019.

The Centre is a reference point, both locally and internationally, for research, education and knowledge transfer activities in the field of family business. The Centre conducts international and interdisciplinary research, in collaboration with other research institutes, on the distinctive organizational goals, strategic processes, innovation, succession, and outcomes engendered by family involvement in business.

- LAIMBURGH

More than 40 years in the market, Laimburg Research Centre is the leading research institute for agriculture and food quality in South Tyrol.

Big retailers used their recommendation in the way of how they should deal with the conservation of their products.

It performs applied research with the objectives of improving the competitiveness and sustainability of agriculture in South Tyrol and of ensuring the quality of agricultural products.

An specific lab called The Laboratory for Flavors and Metabolites carries out studies on food quality and plant health. It uses state-of-the-art analytical methods to investigate the naturally occurring substances found in agricultural products (apples, apple juice, grapes, wine, cheese, milk) and plant parts (leaves, roots, stems, trunks). A really specific field where companies with high level of investment decide to put all their efforts in an environment that help to all this growing process.

- FRAUNHOFER

Innovation is one of the most important factors driving business success, and in the NOI TECH park is a feature that it’s impossible to put aside.

This is why Fraunhofer Italia focuses intensively on trends and megatrends as well as the challenges they create for companies, especially small and medium-sized enterprises.

The main focus of this company is about the process of transformation companies into the digital world.

The researchers at Fraunhofer Italia help companies to gain access to and apply Industry 4.0 principles, concentrating their efforts on both the manufacturing and construction industries. Moreover, besides assisting companies with technology and market research, Fraunhofer Italia also supports them to develop innovative business models.

- Casaclima

ClimateHouse is an advisory body established by the autonomous province of South Tyrol. It promotes energy-efficient and sustainable building activities and organizes campaigns for raising public awareness of sustainability and climate protection. Following the trend of being conscious about the higher amounts of energy and gas that is spent in heating and cooling process.

The agency's responsibilities include the introduction of measures aimed at achieving the energy policy and climate protection objectives set by the climate strategy paper "Energy South Tyrol 2050". A plan that was built following the European Union plans, but even being stricter.

Besides assessing the quality of buildings and products in terms of their energy efficiency and impact on the environment, the agency offers a wide range of education and training opportunities for all professions involved in the construction process. The ClimateHouse Agency has developed special programs which support businesses and local administration to become more energy efficient and sustainable.

City	Bolzano
Initiative	South Tyrol government
Area	12 Hectares (120.000 m2)
Specific place	Old ALUMIX factory
Background	WWII melting incredible amounts of aluminum in this zone 2/3 of the whole Italy production, South Tyrol's government decides that the protected buildings are to be used as part of a technology park. In 2007 they Called for tenders in planning competition starts. In 2015 they Started of construction and in 2017 it's the Inauguration of NOI Techpark
Management	IDM Südtirol – Alto Adige. The three pillars of IDM: Innovation, Development and Marketing. Since 2016, has been dealing exclusively with the planning, construction and development of the NOI Techpark. IDM is the result of the merged of BLS, EOS, SMG and TIS

Legal status	Public institution. The shareholder Meeting (60% Province and 40% Chamber of Commerce), the Board of Directors, which appoints the Director, the Chairman of the Board of Directors, the Board of Auditors. The Company's activities are supported by advisory committees.
Public investment	100 million euro
Conditions of the place	City located 9,000 meters above sea level, with snow, rain, and icy temperatures.
CONSTRUCTOR	BLS Business Location Sudtirol
OBJECTIVES	The objectives are create a working-research-living area where is possible to target 4 main edges. 1. Green Technologies 2.Alpine technologies 3. Food technologies 4. ICT & Automation
NETWORK	To manage and control each of the 4 main goals the NOI TECHPARK is divided in ECOSYSTEM that work specifically in each topic. 8 ecosystems

Figura 7: NOITECH BOLZANO

10.1.2 Case Smart Living 2 (Milano Segrate 4you) [2]

Milano 4You is an innovative project that as they described is the joining forces of professionalism and innovation. From the building automation, till the electric mobility passing by the Energy management and IoT infrastructure are the main steps and edges of the project. A new way to build, a new way to cooperate. The company on charge of this transformation process is called RED S.R.L.

This company together with IBM, SAMSUNG, and Politecnico di Milano played together to bring the result as new smart society that have everything in the same place.

The main objective: Create the first completely digital city, with high standards of safeness and social inclusion to all the citizens that are part of the city. Having all the benefits of being part of this community.

Urban design: Innovative and integrative eco system

Not just in the final result, but taking into account the materials and different techniques in the building and construction phase.

Understanding that the key process is creating certain circle of talent and a constant feedback from the engaged citizens. For that the project focus on co-working, and smart working places. It's a new way to live and to work as well.
In summary, the project point is to have a city of zero cost, without leaving the comfort, the efficiency and lower management cost. In collaboration with Politecnico di Milano, a bunch of solutions merged and helped to reduce the management cost. Building thermo isolated, thermal plants and electric efficiency help in all this solution.

Nonetheless, the project takes into account that the citizens will develop a high level of awareness in the way that they control the use of the natural resources, creating type of citizen's certification and culture of the way to optimized them.

The electric mobility is something that plays an important role in this business case and they have different alternatives for citizens with bike and car sharing and increasing the public transportation around the neighborhood. A domotic- efficient system that guaranteed the control by remote of all the domestic applications, without any doubts create a new smart living process. All the previous information concluded in a simple but clear impact, a surplus/ benefit for all the citizens where the normal public expenses are so much lower, and the quality of life is radically higher, plus the increased price of valorization of the property due to this fact. In this way, the creation of platforms for the communication of the community is something absolutely necessary. Because the only way to maintain the control and the efficiency is engaging all the citizens towards the same goals, so this society created a software called Street Community, where are the citizens are participant users and where forum of discussions is always open.

MILANO4YOU	Segrate
City	Segrate
Inicitative	Comune di Segrate
Area	300.000 m2
Specific place	Comune di Segrate
Background	In 2005 150 families made an investment to buy a house in a project Known as Santa Monica. So this investment is to solve that past issue.
Management	R.E.D managed for Angello Turi and Sagnelli Associati Studio of architectures.
Legal status	Public investments and studios.

Public investment	200 million
CONSTRUCTOR	Phoenix development (Germany) 350 MM euro.
OBJECTIVES	The objectives are: 1. Living sustainable 2. Mobility 3. Environment 4. Energy solutions 5. Avant-garde architecture
Network	SAMSUNG VODAFONE
	POLITECNICO DI MILANO
	Shopping malls outlets
	IBM, SYMATEC, 3M, LEXMARK
	Ospedale San Rafael

Figura 8: Milano Segrate smart neighborhood model

10.1.3 Case Smart Living 3 (Milano Santa Giulia) [5]

A new neighborhood built in two different sections. South and North part.

Rogoredo district that was the first one to be build that is composed by 1.800 family houses, the headquarters of Sky, and a big park called Parco Trapezio, personal services (nursery and RSA), a shopping and entertainment street (Promenade).

The north zone instead, which will be composed of a large urban park and a new section of the development that will include apartments, offices, a retail and entertainment district and a network of footpaths, squares and public spaces. Sustainability, smartness and integration with Milan's metropolitan area are the guiding principles behind the new neighborhood.

The concept is similar to the other cities that were already mentioned. However, it's important to clarify when a city is already built or where the project manager takes the decision to put it down and rebuild it new again. This project is particular in that way because a lot of the infrastructure where rebuilt. A lot of Green spaces, services, leisure time, work and connections. An innovative district that can predict the future and make it a reality for the daily lives of those who live, work and plan their lives in an urban context.

Nowadays, being connected is an essential need and being connected efficiently makes all the difference. The position and the connection infrastructure will allow easy access to the metropolitan area and destinations further away.

Milano Santa Giulia	Milano
City	Milano
Initiative	Commissioned by Risanamento
Area	296 acres (1.200.000 m2)
Specific place	SE of the city, near Milan's Rogoredo and Taliedo districts
Background	A city within a city, projected into the future and designed to meet the needs of the people who live there: Milano Santa Giulia is an "ideal city." Idea originally born in 2004, commissioned by Risanamento, partnered with Foster & Partners. The final result was to propose a new design idea, characterized by a strong identity based on three key elements: An open neighborhood, not exclusive, but focused on social integration. A neighborhood with a high degree of innovation built around two core values: sustainability and smartness. A district that can become a benchmark, nationally and internationally, for positive integration with its surroundings (metropolitan Milan) and an effective balance between residential use, commercial use and collective interests.
Management	Leading architect: Norman Foster (UK) / Foster & Partners Developer: Risanamento / Zunino Group (owners of the property)
Legal status	Public institution.
Public investment	1,2 billion euro
Conditions of the place	The city's land is flat, the highest point being at 122 m (400.26 ft) above sea level. Humid subtropical climate; the mean number of days with precipitation per year is one of the lowest in Europe, the Alps and Apennine Mountains form a natural barrier that protects the city from the major circulations coming from northern Europe and the sea; typically heavy fog, wind generally absent.
CONSTRUCTOR	Lendlease
OBJECTIVES	The idea behind the Milano Santa Giulia development, therefore,

	is to represent a virtuous model for the metropolitan area of Milan and, more generally, across Italy, by creating a sustainable balance and combination of residential areas, green spaces, offices, commercial areas and venues of cultural interest. To achieve this objective, the project is designed according to three themes that represent the fundamental guidelines for the concept of sustainability: Social Sustainability Environmental Sustainability Economic Sustainability
SUBDIVISION	The new urban area will be a compact district composed of tree-lined avenues, residential streets, pedestrian and cycle routes, plazas and gardens, all set around a large park that will be at the heart of the development. A typically urban, accessible and practical space in which living, working and passing time will be simple and fulfilling.

Figura 9: Milano Santa Giulia

10.2 Cases of analysis Smart Mobility

In comparison with the other pillars, the smart mobility trend was one of the most adopted all around the world. The cases that are going to be analyze are two different types, the first one was more of how born this type of initiative within the country (United States) and which were the steps that it took to achieve certain improvement on the mobility. In the other hand, this paper will highlight some projects developed in Europe-Italy (ZEEUS project) in the main cities and the decision that the government took to implement the electric mobility around the cities. [11,20, 28-30]

10.2.1 CASE SMART MOBILITY 1(United Stated transition on Smart Mobility) [11]

Transportation implies the analysis of the entire population of a country and city, and all the different social gaps that they have, like rich people, medium class and poor, young and old, basically including all the segments.

The main way is aligning all elements, so in this specific case the vision found 12 ELEMENTS. Even if the main aim was focusing in transportation, this type of new infrastructure can address another thing like improve safety, enhance mobility, enhance ladders of opportunity, accelerate the transition to clean transportation, and address climate change.

In this specific case its necessary to categorize for the priority to work on the elements.

This is an example of seventy-eight cities submitted entries to the competition, and in March 2016, seven finalists were selected. These finalists were Austin, TX; Columbus, OH; Denver, CO; Kansas City, MO; Pittsburgh, PA; Portland, OR; and San Francisco, CA. Finalists were awarded $100,000 to develop detailed applications on their proposed plans to conduct a federally funded Smart City Demonstration in their jurisdiction.

The first case that will be analyzed is COLUMBUS whose got 50 million dollars from USDOT to address the aim proposed that was budget on 90 million dollars. Will be a project that have a deadline of four years and will impact industry of (residential, commercial, downtown, and logistics).

To tackle this initiative COLUMBUS started with 8 smart solutions:

- Connected Columbus transportation network
- Integrated data exchange
- Enhanced human services
- EV infrastructure
- CCTN: Bike sharing, Wi fi hot spots, parking availability, carsharing information, traffic detections and sensors,
- Just better data
- EHS: For resident and visitors, multimodal trip app, common payment system,
- EVI: V2G program, ev charging increase, customer education programs, EV cooperative buying program

This example highlight which is the road to achieve certain level of smart mobility within a city.

10.2.2 CASE SMART MOBILITY 2 (ZEEUS PROJECT) [20,28-30]

ZeEUS is a European project which aim to develop and spread electrification of urban buses and which serves as a lighthouse to guide the transition towards low and zero emission urban mobility.

The declared scope of the project is “Testing electrification solutions at the heart of the urban bus system network through live urban demonstrations and facilitating the market uptake of electric buses in Europe”.

ZeEUS tested several different innovative e-bus technologies and charging infrastructure solutions, with different operational conditions to validate their economic, environmental and social viability. The test was performed in ten demonstration sites across Europe and one of these sites was the Italian city of Cagliari.

The project has the key objectives to:

- Extend fully-electric solution to the core part of the urban bus network;

- Evaluate the economic, environmental and societal feasibility of electric urban bus systems through live operational scenarios across Europe;
- Facilitate the market uptake of electric buses in Europe with dedicated support tools and actions;
- Support decision-makers with guidelines and tools on "if", "how" and "when" to introduce electric buses.
- The ZeEus project focuses the effort only on the following categories of electric buses:
- Plug-in hybrid buses (PHEVs);
- Full battery electric buses (BEVs);

Battery trolleybuses: also referred to as dual-mode trolleybuses, called also hybrid trolleybuses.

The ZeEUS project focuses its activities on the so-called “high-capacity buses”: buses that can carry at least 55 passengers, including both standing and sitting. The vehicles included are currently in full revenue operation or will be ready for exploitation by December 2017 at the latest. For the aim of this paper 2 main cities will be analyzed (Turin and Milan).

10.2.2.1TURIN

In 2017, Turin has become the first Italian city having 12-meters electric buses operating in the streets thanks to the project realized by Government of Turin Gtt. The supplier is the Chinese company Byd and the buses can transport up to 77 people (21 of which seated) and a wheelchair. They have an autonomy of 310km and an average consumption equal to 104kWh each 100km. This will allow the buses to operate all day long without any charge in line. They are equipped with a lowered floor, air conditioning system, video surveillance, internal and external panels showing information and three doors (the anterior one is rotating, the central and the posterior are sliding).

Two charging stations have been installed in the Gtt deposit in Gerbido and Tortona and the buses are charged there in a maximum time of 5 hours.

The electric buses are very silent: for this reason, they have been equipped with an acoustic speaker that worries pedestrians and bikers about their presence.

Figura 10: Byd electric bus decorated by the Accademia Albertina di Belle Arti di Torino

Since October 2017, the electric buses are operating in Turin in the lines 6 and 19. The new line 6 has substituted the old line 6 (tram) to improve the accessibility to the university and it will head to piazza Hermada and Porta Nuova. Line 19, previously managed with traditional buses, extended the path previously travelled. Starting from January 2018, the

buses are operating in lines SE1 and SE2 in Settimo Torinese as well, and from February 2018 they are also used on the new line CP1 that serves the municipalities of Collegno and Pianezza.

Gtt had to face some issues so far: in the first two days in which the electric buses were operative, 2 faults have been registered in line 6. This lead to the substitution of the buses with traditional (gasoline fuelled) ones. Even if the problems were not big ones (one was about the internal lights of the bus, while the other one was about the opening of the doors not properly working) the system needs a trial phase before reaching the expected efficiency.

The buses are operating in the line 5, which has a path that follows the busiest area of the city.

10.2.2.2 MILAN

The most ambitious project is probably the announced by Atm Milano, which in 2017 has done an auction for 20 electric buses won by Solaris, which presented its offer against the one of Irizar. It was the first time that Atm was dealing with electric buses for Milan, following the aforementioned Italian projects in Piemonte and Bergamo.

Figura 11: Solaris' electric bus bought by Atm in Milan

The typology of electric buses bought by Atm is the same of the ones operating in Bergamo: 12 meters buses powered by two engines of 125 kW each. Each electric bus will rely upon 240kWh of energy stock capacity and with an autonomy of about 180km, a top speed of 70km/h and a charging time equal to 5 hours.

The new electric buses will start operating in the Line 84, that runs the path San Donato – Largo Augusto. This is only the first step of a broader project that anticipate, by the end of 2018, a tender for 175 electric buses. Ten more buses will become operative in April 2018, and 15 more in the next autumn.

Arrigo Giana, the new general manager of Atm, announced that the objective is to invest 1 billion euros in the next five years for the electrification of the public transport in Milan: they announced their plan to have, by 2030, all the fleet made by only electric buses, replacing the current 1200 ones in the fleet. In detail, starting from 2020, Atm will buy exclusively electric buses. Nowadays 97% of Atm's buses is diesel fuelled. From 2020, this amount will be reduced to 60% (25% hybrid buses, 15% electric buses); in 2028, 80% of the fleet will be made of electric buses, while 20% will be hybrid buses. In 2030 100% of the buses will be electric. All the deposit will need changes, and three new innovative structures will be built ex-novo.

Thanks to these planned changes, the forecasts say that CO2 production will be reduced by 75 thousand tons every year.

10.3 Cases of analysis Smart Working

10.3.1 Cases Smart Working (INNOVA TO Smart community in Turin) [19]

In order to limit the social and economic consequences, such as the increase of the public debt and the unemployment rate, over the last decades, the city's administration implemented a strategic plan to convert Turin into a technological and cultural city. However, the financial crisis of 2008 hit the Turin's economy again. Frightened by the risk to remain tricked into stagnation, in 2011, the public administration launched the Torino Smart City Foundation, in order to reinforce the brand of Turin as a technological and intelligent city. One year later, the city launched the Torino Social Innovation strategy. Since then, the city government has been undertaking several initiatives to support local technological and social innovation, promoting networks, workshops, partnerships with local organizations and also opening the Centre for Open Innovation to involve the Turin's citizenship into the process.

This is one of the first successful initiative within the government, and was launched as a pioneering case of a virtuous competition. One of the main features was leaving outside the executives and directors.

The employees who were the ones that normally for the day by day job have more knowledge about their specific tasks, started proponing innovative ideas that could be adapted to raise up their performance. In the areas that they started proponing were: costs rationalization, procedures' simplification, data sharing, improvement of the service level, efficiency of territorial management and control systems and improvement of the working environment.

Contrary to the normal tendency of approach were the proposal of innovation goes down following a cascade effect, the basic idea of this project was to stimulate bottom-up innovation through the aggregation of people who co-participate to enhance the level of service of their work.

Furthermore, the projects were all of them following certain rules like no additional costs, technical feasibility in the short-term and medium term periods, tangible results and could be developed by usage of internal personnel and environmentally friendly.

An ICT collaborative platform was developed and entirely dedicated to Innova.TO where employees could search for allies, interact, ask questions, share their proposals, gather documents and information about the competition and submit their proposals. In this way they create a network of 4,000 employees interacted with the platform, and 71 projects were submitted by 111 employees. The final opinion was given for a panel of experts that evaluated them.

In that way the employees have a higher belonging sense for the city and for the main task that they develop day by day, transforming in this way those employees in real protagonist of the innovation of the city.

Start observing Turin under the premise of "Turin Municipality: 10,500 public employees – 10,500 potential innovators" completely open the view and the way of evaluated employees.

However, was necessary to find a way to give this competition a signal the reliability, the followed steps were, first, the evaluation panel was composed of experts internal and external to the municipality; second, it was given the possibility to send the applications anonymously, separated from the name of the applicants; third, executives were excluded from the competition, to stimulate bottom-up innovation and do not make employees and middle managers feel discouraged; fourth, it dedicated an online platform to the project, to let employees interact, share ideas, submit their applications and let the smart community coalesce; and finally, it established public-private partnerships with private sponsors. The private sponsorships were of help for several reasons

One of the main constrain in this type of project is what was mentioned before: The budget. Innova was decided to be a project with zero budget to invest. However the sponsor were giving good awards to the winners. Besides, the involvement of private partners increased the external and internal recognition of the project and its consensus.

Another important part of the project was categorized the proposals and the main categories were:

- improvement of transparency and accessibility to services
- organizational development
- operative efficiency
- the delivery of new services
- environment and energy efficiency
- employees well-being
- and paperless and ICT solutions

Apart of all the good implementation that this project had, Innova suffer multiple difficulties in the implementation stage. Some conclusion that were taken of that stage were from a practical point of view, three main issues can be brought.

First, it becomes hard for SCC managers to abandon an ongoing innovation process whenever internal and external consensus is reached, the endorsement of innovation champions is obtained and a formal process is enacted. The case showed that the interaction with external communities increases the internal legitimacy. Under this perspective, both internal and external communities become interdependent (Breueretal.,2014), and co-participation is not only the end but also the mean through

which public managers enforce the SCC coalescence. The endorsement by the external community of experts brought additional resources, enlarged the focus of the project and avoided it fell in the anecdotal situation of being self-referential overlooking external ideas.

Secondly, as could be expected every time that will be adapted a huge change the community offers resilience. Crossing that bridge is the different between a proposal and a successful case. The Innova.TO case showed that in a routine environment, the SCC managers have to balance the trade-off between stimulating employees' participation and preserving the commitment of who has the decisional power, or, in other word, between creativity and rigidity, otherwise innovation remains circumscribed and its potential does not propagate

Thirdly, in a resistant and highly formalized context such as local governments, the help of technology can lean the process if this has a clear governance that prompts commitment to the initiative, supports and sustains the community and stimulates a participatory approach. Indeed, according to results, face-to-face contacts and interactions are still important to encourage people to co-participate and co-create value and it creates dynamism in the culture resistance that discourages innovation. [19]

10.3.2 Case Smart Working 2 (SILICON VALLEY and the startups) [17]

Another type of smart working is the whole environment for the startups in the Sillicon Valley. In this case is a community that its focus on the development of new technologies and propelling startups and all the world around it function completely different. Meaning that are isolated for many of the other communities, just for the fact of being so different.

In Silicon Valley, the rich social, technical, and productive relationships foster entrepreneurship, experimentation, and collective learning. Thus, the region's social, technical, and productive infrastructure is as critical to the successes of local firms as their own individual activities.

The network system, by linking public, private, and academic organizations, facilitates collective learning, providing a regional advantage to Silicon Valley firms in today's very turbulent, competitive environment. In this way they were able to create a new type of Smart community.

Certain factors that were identified were good communication network, cooperation between companies, workforce mobility, forums, capital leadership, participation of universities, and so on. Therefore, it is possible to obtain the desire fluidity of the system enables people with innovative ideas and implement them in a quicker way.

Silicon Valley has excelled in each of these and, as result, has been able to spawn start-ups much faster and more successfully than anywhere else.

“Silicon Valley is like the rainforest: it’s a decentralized system with complex and a continually diversifying mix of species, flora, and fauna that spontaneously and repeatedly cross-pollinate”. The case of Silicon Valley illustrates the complex connection between innovation, competition, collaboration, relationships, and social capital. [17]

10.4 Cases of analysis Smart Environment

As was mention before the smart environment will be split focusing on two big branches; the environmental side (emission, pollution and waste) and the energy generation.

For these branches will be analyze the case of the city of Milan in relation with the green houses gases emission and noise due to the transportation, saying that could be mentioned in the chapter of solutions for smart mobility as well, for the first part. Afterwards, will be analyze an example of managing waste, finishing with the analysis of an energy community.

10.4.1 Case Smart Environment 1 (Milan Green Gases Emission and noise) [1,3,23]

Nowadays, the city of Milan has many problems related to local air pollution. It is a big city in the middle of the Pianura Padana, one of the most industrialized area of Europe with a geographical configuration that does not allow to the air to change frequently. As explained in other paragraphs of the report, public transportation is one of the causes that contribute to maintain high the level of polluting emissions, due to the fact that the bus fleet of Milan is still composed mainly by diesel vehicles.

The analysis is focused on the city of Milan, since it is the biggest Italian city which has adopted e-buses solutions, and it is the one with the most ambitious projects for future electrification of public transport. [3]

The comparison is made between the two newest buses owned by Atm: Iveco UrbanWay (diesel bus bought in 2017, one of the newest and most advanced diesel buses) with Solaris Urbino 12 (the e-bus bought in 2017). More detailed description of the two solutions are in the paragraph about the analysis of TCO.

Diesel buses emit some harmful substances for humans and for the ecosystem when they are operative. Their main emissions are: CO_2 (carbon dioxide), PM10 (particulate matter), NO_x (nitrogen oxides), CO (carbon oxide) and HC (hydrocarbons). [1]

EVs, like Solaris Urbino 12, emit no tailpipe emissions like CO2, CO, NOx, HC and PM10 that conventional diesel ICEVs, like Iveco Urban Way. In particular the estimation of the saved emissions at local level using the following assumptions:

Lifetime: A general assumption that the average life of a bus (electric or diesel) is 15 years. After that, its operations and maintenance costs become higher and higher induce

the owner (ATM in this case) to replace it with a new one that is economically more convenient.

Distance travelled per year: the average distance travelled during by a bus in Milan is 40,000km (source: ATM)

Emissions of the Iveco Urban Way: The problem is to identify information about the diesel bus emissions of each of the pollutants. Neither Iveco nor Atm made this information public, thus we used as an estimation the limit values established by the most recent emission class – Euro VI. The tailpipe emissions considered in this paragraph are CO2, CO, NOx, HC and PM10.

The overall emission results are shown in the next table:

	Euro VI emission	Annual emission	Emission during lifetime (15 years)
	(g/km)	(kg/year)	kg
CO2	915	36,600	549,000
PM10	0.005	0.2	3
NOx	0.125	5	75
CO	0.74	29.6	444
HC	0.09	3.6	54

Figura 12: Emission results Milano

What emerges from the analysis is that, thanks to the usage of Solaris Urbino 12 instead of Iveco UrbanWay, all the tailpipe emissions can be saved. Over the 15-years' timeframe, if, starting from now, Atm would substitute the 125 Iveco UrbanWay owned with 125 Solaris Urbino 12, the avoided emissions would be huge: more than 68,000tonCO_2, 375kg of PM10, 9,375kg of NO_x, more than 55,000kg of CO and 6,750kg of HC. [3]

However, for what it concerns the global emissions related to the usage of the electric buses the situation is different. The noxious polluting agents due to the production of the electrical energy needed for running the buses depends on the production energy mix and it is today a side-effect related to the adoption of electric vehicles. The more the production mix is composed by low-carbon intensity production technology, the greener is the usage of the buses also from a global perspective. According to The Italian National Energy Strategy («SEN») ambitious goals in terms of electricity produced by RES and coal phase-down are settled for the next years.

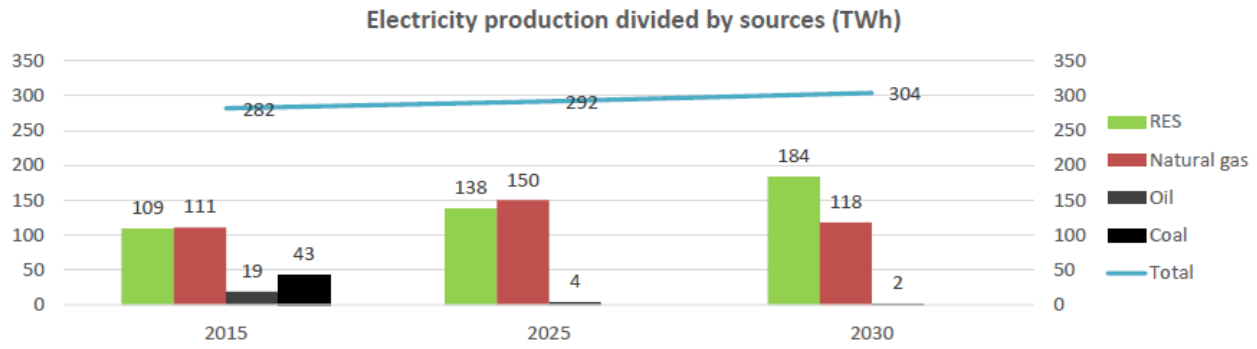


Figura 13: Italian electricity production by sources (TWh)

If the projections of the Italian Energy Strategy will be respected also the issue related to the global pollution of electric buses due to electricity production will be solved, at least for the Italian case.

The noise pollution is one of the biggest consequences of the mobility diffusion in the world, but is also one of the most hidden in terms of impact to the citizens of big cities, the most affected by the phenomena. In Europe only, the acoustic pollution has each year in terms of social-economic cost an impact around 40 billion euros, 90% generated by the mobility.

The cost is evaluated considering also the non-direct cost related to disturbs linked to the noise: depreciation of houses in some zones particularly busy, losses of productivity for some industrial plant and the list can continue.

In Europe exist a law that regulate the determination and management of noise pollution by the member states of the community. The first request of this law is that the states must create some maps to calculate the noise threshold in some particularly affected cities, zone to zone, to estimate how many people are over the threshold of 55 decibel, considered as risky for the health of people. Diseases linked to noise pollution are many, from disturbs linked to the sleep to heart diseases. For this reason, the European commission is alerted about this theme and many cities independently develop each year new projects to monitor or reduce the acoustic pollution. One of the most important project in terms of mapping the noise in the cities is the DYNAMAP project, launched here in Italy in two pilot cities (Milan and Rome).

The scope of this project is to reduce the costs for governments in terms of mapping the acoustic noise using sensors distributed around the city that update the maps in real time, giving also more information about statistics respect to the surveys done to calculate the noise in sporadic days.

Going more in detail in this paper, the impact of electric buses in terms of noise pollution is very huge, especially compared with the classic buses (Diesel and CNG) or other facilities as metro or tram.

A study made in eight different Swedish municipalities compared 9 different models (3 electric buses, 3 diesel buses and 3 CNG buses) of buses calculating in real situations the noise thanks to some microphone put around the buses. The results are optimized considering the difference of environment noise in dBA during different measurements and the wind influence in data. The tests considered three different conditions: Acceleration phase, Constant speed phase and Stop phase. [23]

The impact in terms of noise reduction with electric buses when buses are stopped or in acceleration phase, in constant speed situation, the effect of different power train is reduced by the noise coming from tires on asphalt and vibrations of the bus.

These tests show good results but is quite difficult to analyze the real effect of electrification of buses as impact in transportation, due to the presence of tram and cars traffic that constitute the higher percentage of noise pollution.

Surely the noise is a negative externality for citizens and for this reason is a duty for governments take in account all possible solutions as electric transportation, but electric buses alone can reduce a very small part of the problem if the intervention is not more radical and definitive. [1,3,23]

10.4.2 Case Smart Environment 2 (MORGENSTADT MODEL) [27]

The Morgenstadt initiative is not only about the city in general, but also about the neighborhood level.

Reach an integrated energy community requires certain infrastructure, this concepts can also be used for a district in general. Mobility and logistics are linked to the intelligent urban space and intelligent parking space. Micro Smart Grids provide energy for smart buildings, etc.

In addition, the innovative neighborhood infrastructure and services (for all process phases from planning to realization and implementation) regarding the technology requirements (individual technologies and application bundles), the process model and the operator model must be analyzed and planned.

Once the model was already explaining in detail, the paper shows the particularities of each of the next different energy communities projects, where each of them through different approaches reach a high level of efficiency and energy and digital transformation.

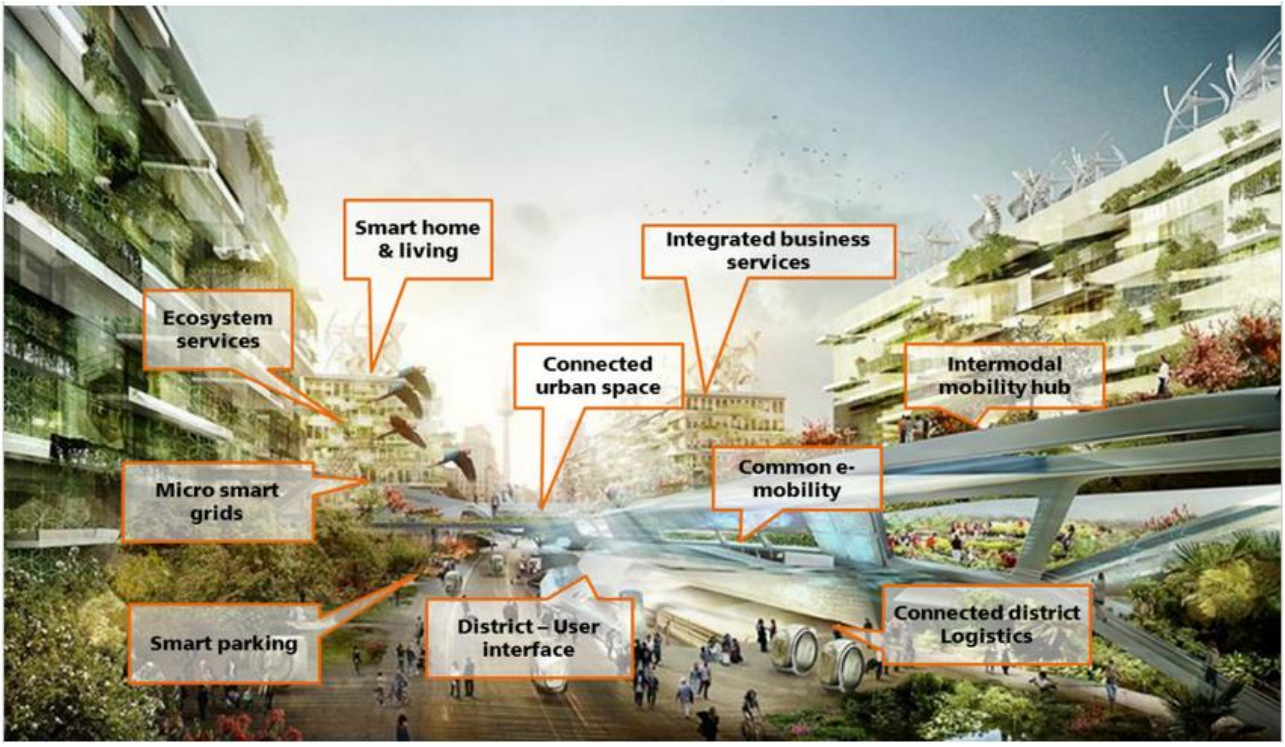


Figura 14: Action plan Morgenstadt model

This project started mainly understanding that the urban knowledge economy is facing a tremendous transformation that will affect the society technologically, organizationally and systemically. Individual technological sectors, such as energy or mobility, will be affected. But since these sectors are highly cross linked, especially in cities and urban regions, the change in one sector will affect all others and the urban system itself as well.

In Morgenstadt project involved all that factors together and was trying to achieve this goal a holistic research approach was developed in order to analyze the city system in its interdependent structure.

The project was focus on many sectors not just in the energy that will be the main focus of this part of the project, the main points of the project are represented in the below figure.

Figura 15: Points of interest Morgenstadt project.

The project plan has many stages, the first one was finding the status quo of the city and stablish a starting point for the research and development of innovations for urban systems. Afterwards is the process of defining certain cities that are already leaders in this type of urban innovation and follow their steps, by detecting and analyzing innovative but already field-tested approaches, their feasibility for other complex environments and demands for an urban future will be evaluated. To verify this expertise will be pooled to develop smart and individually customized strategies. All the description of the flux can be appreciating in the next figure.

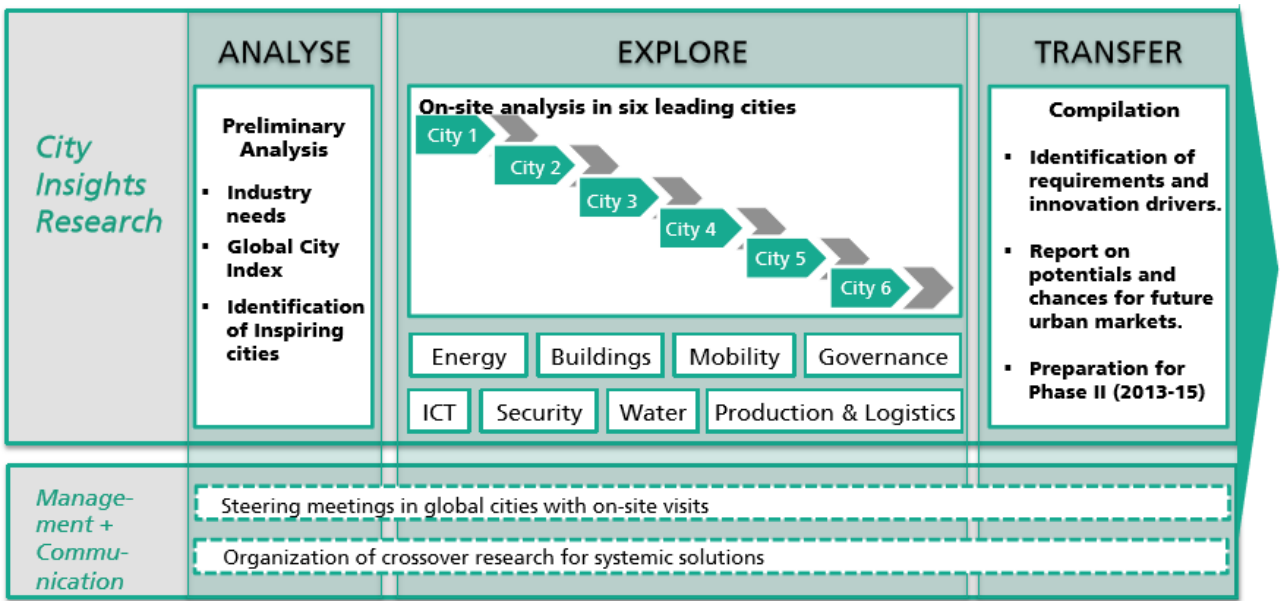


Figura 16: Initial flux of the Morgenstadt project

Deeping in the energy aspect the leading city was Berlin and the project try to reply the technology and developments of the Smart Grids and Smart Metering Berlin – Brandenburg. Certain aspect define the energy community created in this city inside couple of their neighborhoods, where they focus their efforts on:

- Local energy renewable production (Mainly photovoltaic)
- Static energy storage (Charging's docks, Redox Batteries)

- Micro- grid
- Inductive charging infrastructure
- Low voltage buildings (LEED certification)
- Electric vehicles and urban mobility
- Load management
- Production management

The representation of the energy communities created within the city is shown in the next figures

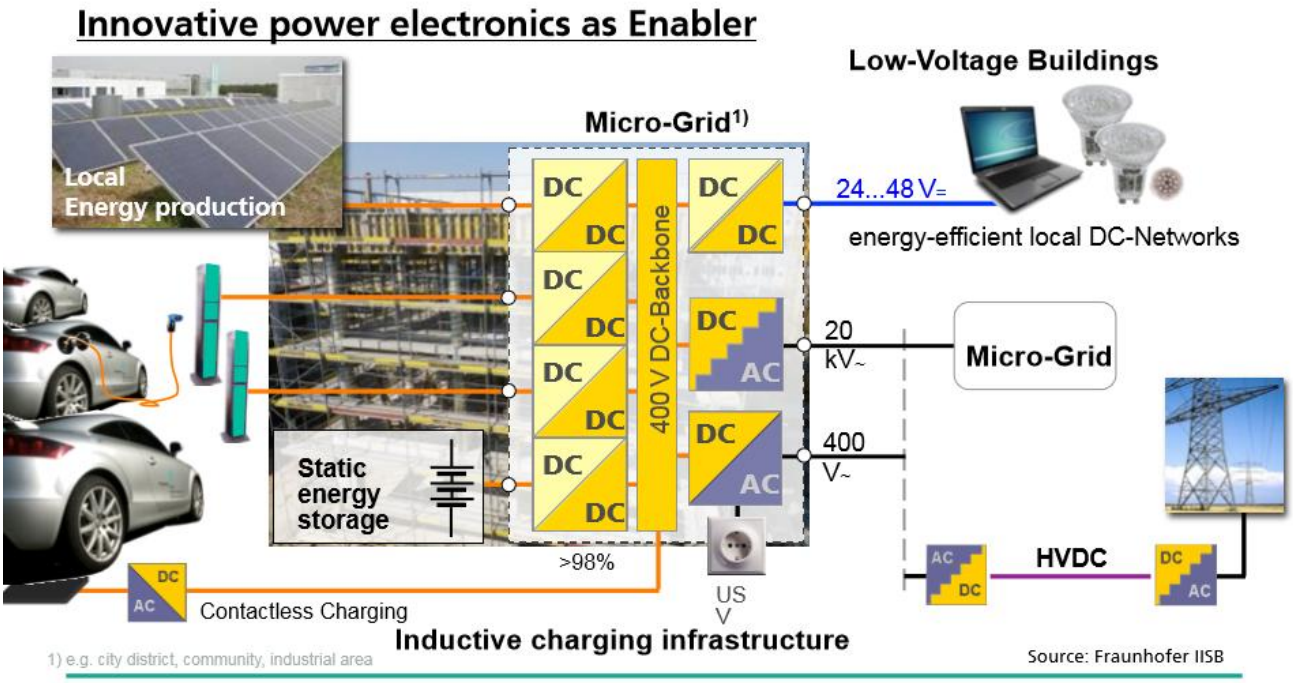


Figura 17: Fraunhofer project developer illustration of the energy community of Morgenstadt

Substantially, this production is pushing towards developing Energy Efficient Buildings with functional surfaces. About the technologies of production are Solar, thermal, the typical silicon photovoltaics panels and alternative PV technologies (hydrogen).

The total production from renewable source is the 81% of the total energy produced for the city.

The main characteristic of the solar thermal energy that the government of the region focus on is trying to increase the solar fraction per building and have different uses from hot water to Solar-Active-Houses. At the same time enlarge the type of applications, having Large systems, district heating, process heat, higher temperature, solar assisted cooling.

But the point where all of this factor create at the end a community is in the applications of these type of technologies, where one/two/ multifamily homes started sharing energy with two chain of hotels, hospital and residential buildings, mainly in the domestic hot water and heating space. The applicability of multifunctional facades plays an important role increasing the energy capacity. And an internal system of solar assisted cooling and refrigeration.

A comprehensive transformation of the energy system must be realized with renewable energies, efficiency in energy production, distribution and consumption, smart grids, e-mobility, storages, zero energy buildings.

About the static energy storage & microgrid creation for the energy community they play a main role. The microgrid is a local grid consisting of distributed generators, energy storage systems, and dispersed loads, which may operate in both grid-connected or islanded modes. The generators are often connected to the microgrid through a power electronic interface converter. The latest technology developments, some performance analysis, and cost considerations are addressed.

The main role of an interface converter is to control the power injection. In addition, the compensation of power quality problems, such as voltage harmonics, can be achieved through proper control strategies

While energy storage technologies do not represent energy sources, they provide valuable added benefits to improve stability power quality, and reliability of supply. Battery technologies have improved significantly in order to meet the challenges of practical electric vehicles and utility applications. Flywheel technologies are now used in advanced nonpolluting uninterruptible power supplies. Advanced capacitors are being considered as energy storage for power quality applications. Superconducting energy storage systems are still in their prototype stages but receiving attention for utility applications.

A draw of the small energy community inside the city is shown below

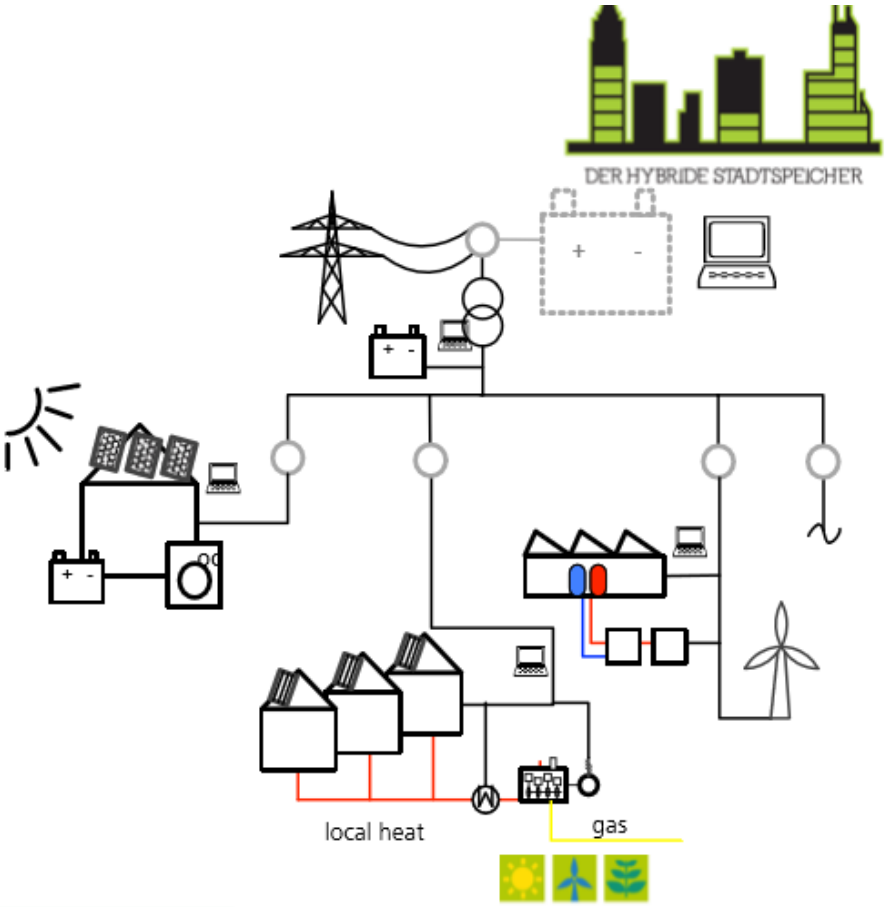


Figura 18: Draw of the energy community flux.

As happened in the smart communities, the energy communities have this element as a fundamental part of successful. The last element of the model is the governance. Apart from the fields of innovation directly targeting specific sectors in a city (mobility, energy, etc.), cross-cutting areas of innovation are present in all areas of urban life and must be considered consistently. One of the cross cutting themes is urban governance & planning, or the “steering” of urban systems. Governance of the city can be both: "top-down", coming from the city authorities, as well as "bottom-up", characterized by impulses from civil society and other non-state actors. The governance arena is characterized by interaction in various forms between many different actors.

The Morgenstadt model mentioned about the governance that the Initiative made clear that effective political leadership is of significant importance for the transformation process towards a sustainable and energy community. A strong leadership, stimulating innovative strategies, motivated city employees, a committed and unified city or municipal council and a wide-reaching and well-executed citizen participation activities are important preconditions for effective interventions.

The Morgenstadt Innovation Network provides valuable tips and suggestions in this important field of innovation. In this context, the network can also assist in improving collaboration between cities and companies. With extensive experience and expertise in know-how of the interdisciplinary Fraunhofer team, it helps to understand the way cities, as well as companies' function.

The problem at the moment to create a model that could be replicable is that city's normally have their own policies. The ambition is to facilitate the diffusion of best practices through learning and to highlight areas where local conditions should be adapted.

Recommendations can be developed by key actors in the city and set into motion by decision-makers as an important early step towards becoming a smart city.

The Morgenstadt model has a City Index that position the cities employees or even a high-ranking leader to see in which areas their city performs very well and where it is falling behind.

The next step is more practical and is to analyses into the internal part of the community, who is on charge of the sustainable leading directions? The pursuit of sustainability demands an integrated approach, but the sustainability agenda in many cities is still conducted by departments divided along sectoral lines that do not work together effectively. Either in the framework of individual projects, City Labs or innovation partnerships, we help bring the relevant actors together and implement concepts collaboratively to overcome this disjointed approach.

Sometimes are still questioning about why transitions for district or transformation of cities take long periods of time, however this type of investments reaches higher levels than the conventional approaches. As an example, the European Commission, through numerous EIP-SCC calls, has invested over € 400 million to develop Smart district lighthouse projects. Subsequently, this strategy has generated over 120 technological Smart City innovations throughout 50 cities within the EU.

Private and public institutions, join with the strength of the governments that try to push this type of initiatives always at the fastest gear something get stop for the longs payback times that certain projects have. Nevertheless, the Morgenstadt model offer an insight into the key challenges that lie ahead for energy communities' projects. Several of these challenges relate to the complex nature of connected solutions, which require new ways of managing, financing and procuring. Along with the technological innovations based on data and connectivity, financing, planning and governing a smart community requires innovations in the area of business models, urban governance and financial instruments.

10.4.3 Case Smart environment 3 (Innovations energy system: Esslingen-Weil)

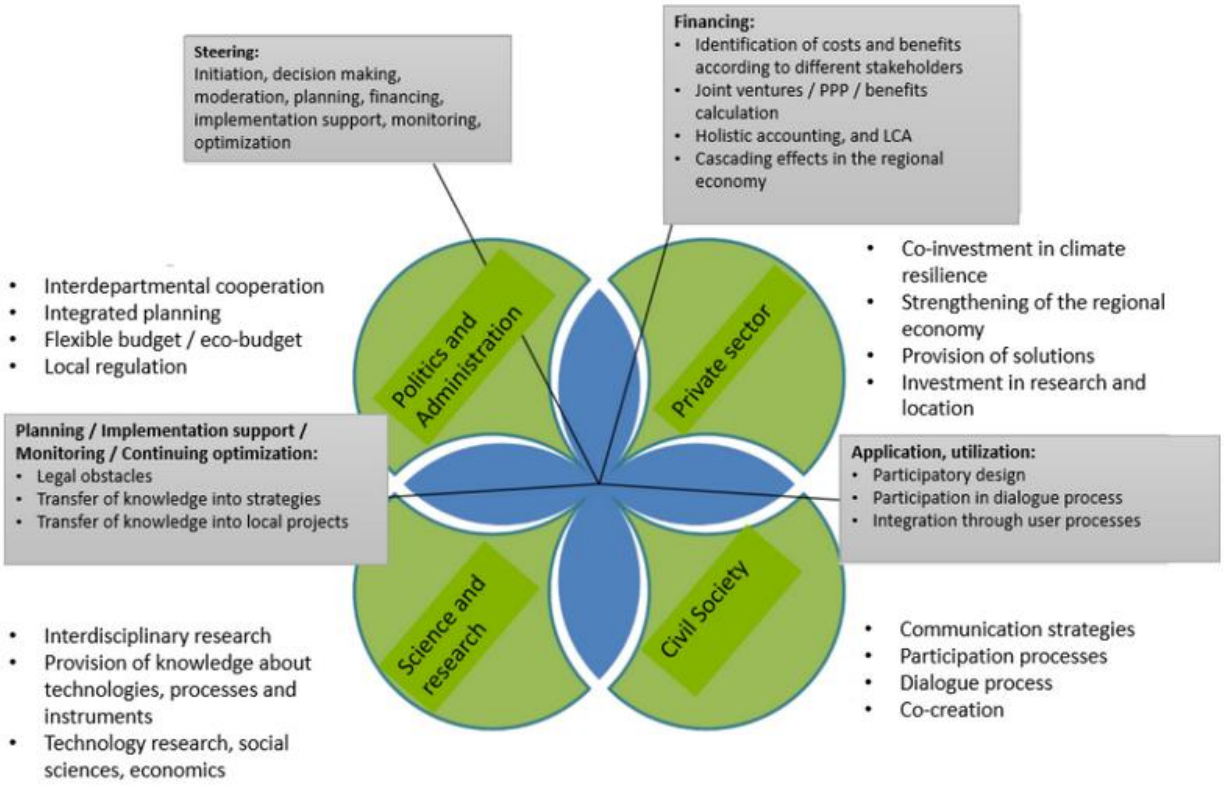


Figura 19: The Esslingen-Weil turbine of progress

The Fraunhofer IAO is developing an implementation concept for the neighborhood development project "Innovationsquartier: Esslingen-Weil", focusing on "social innovations" in the subsequent district operation. For the effective use of the heterogeneous cohabitation potential, innovative concepts for the optimization of community and quality of life as well as a differentiated offer of demand-oriented neighborhood infrastructures are being developed. Thus the focus is on the infrastructure and operating conception for the district as well as development of viable business models to increase the value of the real estate in the life cycle.

- Project initiative:

A neighborhood that is in a stage of developing by the company Buro Godel. Sometimes rebuild is harder that just start from zero.

Are roughly 18,000 m2 of living space in the form of apartments and terraced houses. The framework conditions for the development of a socially fair district with a 75% quota of social housing as the basis for social innovations in the planning and utilization phase were developed in cooperation with planning experts and the city of Esslingen.

The following objectives are to fulfil in the building phase:

Implementation and knowledge development for (socially) sustainable solutions Innovative neighborhood solutions are piloted and put into practice with the aim of enabling new forms of community life

- Creation of new neighborhood-based solutions for social housing The maximum quality of life in the neighborhood is ensured by a differentiated and user-adapted neighborhood infrastructure
- Cooperative planning process with the city administration and other actors The realization is ensured by a collective innovation process between owner, investor, city administration, infrastructure operators and research.
- (Economic) preliminary adjusting of the neighborhood for future requirements Already in the planning phase the neighborhood is being prepared for future infrastructural "upgrades" and ensures maximum profitability.

Applying the model of Morgenstadt for energy communities, the first step is see the accordance of the requirements modules of district vision, viability of every project or development, and see all the administration capacity of the managers. This is all analyzed in the urban design step and describing the utilization concept, traffic infrastructure underground garages, open space, technical building equipment and energy concept. [27]

In order to exploit the potential of a heterogeneous cohabitation and to exclude negative development trends, innovative concepts for the optimization of community and quality of life as well as a differentiated range of demand-oriented district infrastructures are to developed.

This first step in this particular case is based on the following four modules:

- Module 1: "Last-mile logistics" - demand-oriented conceptual design of a technical solution for future-oriented neighborhood supply (delivery transportation, local supply) for online-based logistics processes of service providers (e.g. neighborhood sharing box with coupled parcel station)
- Module 2: "decentralized area grid" - demand-oriented design of a technical solution for a decentralized, smart energy network in the district, which economic potential enables energy recycling for the future supplier or network operator (e.g. waste heat recovery Neckarcenter, photovoltaic with contractor, tenant’s electricity supply model, etc.)
- Module 3: "Shared Uses" – demand-oriented conception of a technical solution for the shared use of different spaces in the neighborhood, e.g. for work or workshops, leisure, assistance or other use

- Module 4: "Smart Home" - a demand-oriented conception of a technical solution for the intelligent and future-oriented equipment of the apartments for "Smart Home & Living" for various user groups (e.g. keyless access system, KNX cabling)

10.4.4 Case Smart Environment 4 (Lighthouses cities TRIANGULUM PROJECT) [14]

Another common type of energy community that is sounding so much as a later project is the one that is focusing on the Cutting-edge concepts for smart district development, those are already emerging as part of European project TRIANGULUM. Project partners were implementing all the technologies in 3 main cities like Manchester, Eindhoven and Stavanger

The core of the energy community plan is a replicable smart city framework and an ICT architecture to connect and coordinate the different technologies in the city.

The plans for the Dutch city of Eindhoven (Netherlands) show how this can be achieved in practice. Among other things, the municipality focuses on electric mobility. The idea is that ICT solutions enable residents to access various areas of the infrastructure, such as to book electric car-sharing vehicles or to use intelligent parking space concepts. Sensors in lanterns, for example, will (among other things) record motion data to allow the monitoring and management of road lighting, public transport or car-sharing offers. This infrastructure will also form an integral part of the Phillips Headquarters' former industrial area, where numerous start-ups, with the support of Triangulum project partners, are designing the solutions for the cities of the future. All focus on the energy consumption and energy efficient of every single device. It’s a different concept of the previous one, different approach but following the same goal.

Stavanger (Norway) has the highest density of electric vehicles in Europe. This and the existing high-speed ICT infrastructures form the basis for better networking of energy and mobility solutions. In addition, companies, residents, research facilities and physicians are to be consistently linked via IT networks in order to improve planning, use more efficient energy, and even provide medical remote diagnosis. One of the driving forces here is the municipal energy provider, which is now generating more revenue from the provision of data and Internet services as well as infrastructure than from the electricity business. Different case happens in Manchester where a type of energy community is created between a lower population.

In Manchester (England), the Corridor student district, which has around 72,000 students, is to be transformed into a smart city district, including the renovation of the historic buildings. In addition, an autonomous "virtual" energy network is in the planning, which supplies the entire city quarter with heat and electricity. The reuse of existing structures promotes the energy conservation concept through building renovation. As part of the area, an alternative mobility concept is implemented for Oxford Street, one of the country's most popular roads, which uses environmentally friendly forms of transport.

10.4.5 Case Smart Environment 5 (ACEA PINEROLESE) [26]

ACEA Pinerolese Industriale is an important company for the region of Piedmont that gather the waste and add certain value to it, mainly in the city of Turin.
Their main activity is related to innovate in field such as lines for the unsorted wastes, a water treatment plant, a landfill and an industrial composter for aerobic digestion and green residues.
However one of the most disruptive projects is related to the transformation of the organic waste, mainly for the anaerobic digestion of the Municipal waste.
Recent biomethane laws provided incentives towards the upgrade of the energy production, usually made by the combined heat and power (CHP) and biogas, to the production of biomethane from biogas. This resource is highly used in the cars industry and to be feed in the grids too.
In 2014 was the first time that Italy incurred in a project with this features. The company addresses, inter alia, the production of biogas via anaerobic digestion (AD), in which heat is supplied by a district heating network in the town of Pinerolo (near Turin).
The anaerobic digestion is due to the organic waste coming from the power of the municipal solid waste of Turin. Since 2014, a portion of the biogas has been converted into biomethane, which can power motor vehicles for civil use.

ACEA found a way to close the loop of feeding their trucks with the biomethane created from their own waste. The service of the company includes 8000.000 people that live and work in 47 municipalities in the South West of Turin. However, the project includes wider perspective as the one that will be highlight below, some numbers of the project are:

- Natural Gas Distribution: 650 km grid, 24 municipalities 85 * 106 Sm3 NG distributed on 35.000 final connection's point.
- Water and waste water services: 61 municipalities for 200.000 inhabitants. 116 waste water treatment system. Clean water grid extended for circa 2.000 km, 850 km for the waste water network.
- Energy services: Acea Pinerolese Energia S.r.l. sells natural gas and electric energy to private sector on the national market

Figura 20: ACEA Waste plant

Figura 21: ACEA waste cycle

The previous figures shown the cycle of the waste and in the way that is handle by ACEA, showing how the Organic humid fraction pass to the anaerobic digestion reactors. Afterwards, the process inside the digestion reactors in additional to the green waste create the compost. That through a process of hydrolysis produce the hydrolysate.
The last one Hydrolysate pass to biogas production reactor, obtaining enhanced biogas production and digestate with reduced ammonia content.
The availability of biowastes from different sources allows obtaining a wide range products that can be tailored to specific applications as can be seen in the figure 20.

11. SMART CITY PADOVA CASE [6]

The model that will be described it is the one developed in the Italian city Padova. Padova Smart city is a project that was developed between the private companies and the public administration of Padova Italian city.

The first goal was to apply ICT in the public administration. The target application consists of a system for collecting environmental data and monitoring the public street lighting by means of wireless nodes, equipped with different kinds of sensors, placed on street light poles and connected to the Internet through a gateway unit.

In the figure below is the graphic description of the project in the general draft.

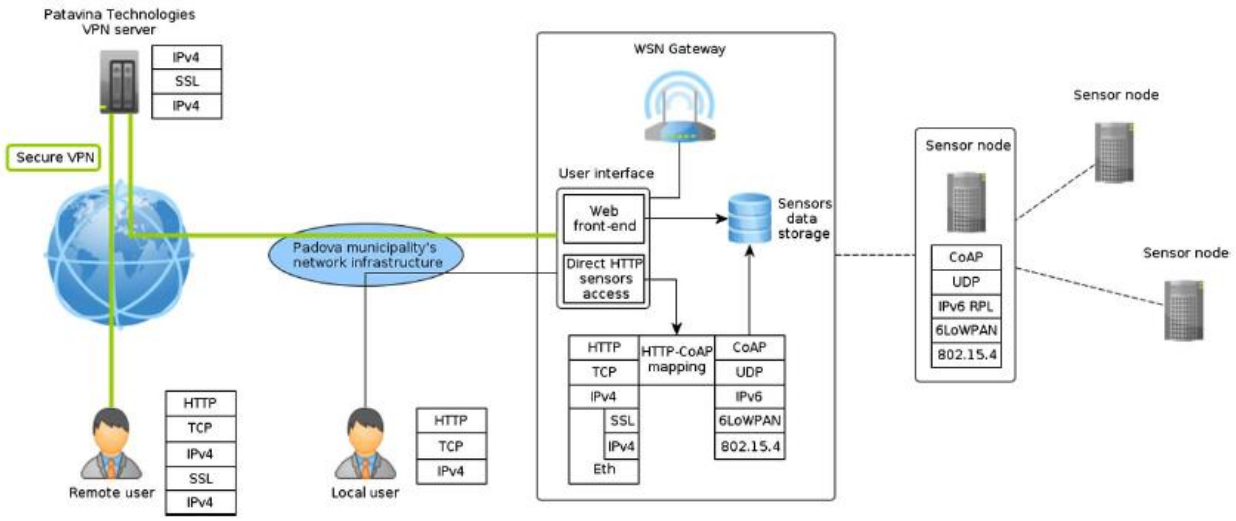


Figura 22: System architecture Padova Smart city

Certain parameters should be measure in the list below that the government try to collect and gathered information

- CO2 level
- Air temperature
- Humidity
- Vibrations noise
- Public lighting system

However, in the figure above are certain hardware and software applied that will be more describe in detail in the description of this case. The description of this process about the devices and the implementations involved certain level of programme language

knowledge, some of the one that was described in the chapter 11, technologies IoT for smart cities.

- Streetlights in Padova:

The bulbs are connected with the photosensor and in that way measure the intensity of the lights on the street. It is the leaf part of the system where IoT nodes are placed. Each streetlight is geographically localized on the city map and uniquely associated to the IoT node attached to it, so that IoT data can be enhanced with context information.

Besides, the IoT wireless have extra gadget about temperature sensors. Those monitors, which monitors air quality as well.

IoT nodes are generally powered by small batteries, though connection to a low-power grid is required by the benzene sensor. The packaging of the sensor nodes has been designed by considering the specific requirements of this use case. Indeed, sensor nodes have been hosted in a transparent plastic shield that protects the electronic parts from atmospheric phenomena (such as rain or snow), while permitting the circulation of air and light for the correct measurement of humidity, temperature, and light intensity.

- Constrained link layer technologies:

The IEEE 802.15.4 develop a link layer technology, the type of nodes that were adapted on the streetlight poles for the network 6LoWPAN

Routing functionalities are provided by the IPv6 Routing Protocol for Low power and Lossy Networks (RPL). IoT nodes are assigned unique IPv6 addresses, suitably compressed according to the 6LoWPAN standard. Each node can be individually accessible from anywhere in the Internet by means of IPv6/6LoWPAN.

Nodes collectively deliver their data to a sink node, which represents the single point of contact for the external nodes. Alternatively, each node might publish its own features and data by running a CoAP server, though this feature is not yet implemented in the test bed. In either case, a gateway is required to bridge the 6LoWPAN cloud to the Internet and perform all the transcoding described in the previous section.

- WSN gateway:

The gateway is adapted to work as a 6LOWPAN border router, with the function of cross the constrained link layer technology. All the previous interactions through the used in the sensors cloud with traditional WAN technologies used to provide connectivity to the central backend servers.

- HTTP- CoAP proxy:

The HTTP-CoAP proxy is the channel of information with CoAP devices. It's a lot of resources that are program to be intervene and check constantly. This mechanism can be supported by two different approaches: 1) by polling the selected resource proactively, thus enabling the implementation of traffic shaping techniques at the proxy or at the gateway and 2) by subscribing to the selected resource using the "observe" functionality of CoAP, thus enabling the server on the node to send the updates only when the value measured by the sensor falls outside a certain range.

- Database server:

In the city the database server is created inside the WSN gateway, providing a transparent interphase in the nodes. The presentation of the information is normally presented as a web site or in many different types of languages. The database server collects the state of the resources that need to be monitored in time by communicating with the HTTP-CoAP proxy server, which in turn takes care of retrieving the required data from the proper source. The data stored in the database are accessible through traditional web programming technologies

- Operator mobile device:

All the lamps send a signal when to the public lighting operators that are ready to may a quick intervention, issue actuation commands directly to the IoT node connected to the lamp, and signal the result of the intervention to the central system that can track every single lamppost and, hence, optimize the maintenance plan.

Service	Network type(s)	Traffic rate	Tolerable delay	Energy source	Feasibility
Structural health	802.15.4; WiFi and Ethernet	1 pkt every 10 min per device	30 min for data; 10 s for alarms	Mostly battery powered	1: easy to realize, but seismograph may be difficult to integrate
Waste management	WiFi; 3G and 4G	1 pkt every hour per device	30 min for data	Battery powered or energy harvesters	2: possible to realize, but requires smart garbage containers
Air quality monitoring	802.15.4; Bluetooth and WiFi	1 pkt every 30 min per device	5 min for data	Photovoltaic panels for each device	1: easy to realize, but greenhouse gas sensors may not be cost effective
Noise monitoring	802.15.4 and Ethernet	1 pkt every 10 min per device	5 min for data; 10 s for alarms	Battery powered or energy harvesters	2: the sound pattern detection scheme may be difficult to implement on constrained devices
Traffic congestion	802.15.4; Bluetooth and WiFi; Ethernet	1 pkt every 10 min per device	5 min for data	Battery powered or energy harvesters	3: requires the realization of both air quality and noise monitoring
City energy consumption	PLC and Ethernet	1 pkt every 10 min per device	5 min for data; tighter requirements for control	Mains powered	2: simple to realize, but requires authorization from energy operators
Smart parking	802.15.4 and Ethernet	On demand	1 min	Energy harvester	1: Smart parking systems are already available on the market and their integration should be simple
Smart lighting	802.15.4; WiFi and Ethernet	On demand	1 min	Mains powered	2: does not present major difficulties, but requires intervention on existing infrastructures
Automation and salubrity of public buildings	802.15.4; WiFi and Ethernet	1 pkt every 10 min for remote monitoring; 1 pck every 30" for in-loco control	5 min for remote monitoring, few seconds for in-loco control	Mains powered and battery powered	2: does not present major difficulties, but requires intervention on existing infrastructures

Figura 23: Padova description process.

Another not so technical implementation of the Padova Smartening process are described below, contrary to the ones shown previously, those are more general and more visible for the citizens.

- Structural Health of Buildings:

To rebuild and maintain the historical buildings of the city are certain sensors that detect deformation, building stress and even detect the pollution levels. The main savings appear due to this database should reduce the need for expensive periodic structural testing by human operators and will allow targeted and proactive maintenance and restoration actions.Those sensors should be interconnected with a control system, and the initial investment was a consider value for all the infrastructure.

- Waste Management:

Managing the waste become one of the main threats and at the same time the main challenges for the nontraditional cities, where due to the fact that the landfills are getting full and with less capacity and every time the waste should be handle with more ecological protocols. A deeper penetration of ICT solutions in this domain, however, may result in significant savings and economical and ecological advantages for the governments and even for the private companies that are involved in the sector.

The main developments in this sector is detecting the level of load of the containers, in that way the sensors send a signal to the central and those are connected with the trucks to collect them, at the same time, following the level of load of the trash containers, a daily schedule route is designed is his geo location platform.

To realize such a smart waste management service, the IoT shall connect the end devices, for instance, intelligent waste containers, to a control center where an optimization software processes the data and determines the filling level

- Air Quality:

One of the main implementation of the city was the installation of sensor around it, that control the level of pollution and green house gases, and emitting signal of the alarm when the level was increasing in big screens easily readable for the entire city of Padova. To such an extent, an urban IoT can provide means to monitor the quality of the air in crowded areas, parks, or fitness trails. In addition, communication facilities can be provided to let health applications running on joggers devices be connected to the infrastructure.

All of that connected create citizens absolutely concern about the environment of the city and not independent acts for each citizen.

The realization of such a service requires that air quality and pollution sensors be deployed across the city and that the sensor data be made publicly available to citizens.

- Noise Monitoring:

Certain places, squares, and highways have been having a problematic with the levels of noise emitted, if the noise can be seen as a form of acoustic pollution as much as carbon oxide (CO) is for air.

An urban IoT can offer a noise monitoring service to measure the amount of noise produced at any given hour in the places that adopt the service.

Besides, this type of devices are used as a enforce public security, detenting with certain level are not in the normal range, for example glass crashes or street brawls.

- Traffic Congestion:

To take relevant decisions about the arrangements on the streets and highways searching for a fluent transit of vehicles, or the presence of officers to control the traffic, the IoT bring a solution for Padova that was installing sensors and camera based traffic monitoring systems for the traffic.

Traffic monitoring may be realized by using the sensing capabilities and GPS installed on modern vehicles, and also adopting a combination of air quality and acoustic sensors along a given road.

- City Energy Consumption:

This could be one of the most technological implementation done in the smart cities. The fact that was installed a service to monitor the energy consumption in the whole city. Therefore, enabling authorities and citizens to get a clear and detailed view of the amount of energy required by the different services (public lighting, transportation, traffic lights, control cameras, heating/ cooling of public buildings, and so on).Increasing in this way the culture of consumption and being more conscientious about it, will of course finish in an effective reduction. Even the fact of the constant measure will lead to a point that will be easier to set priorities. This goes in the direction indicated by the European directive for energy efficiency improvement in the next years. In order to obtain such a service, power draw monitoring devices must be integrated with

the power grid in the city. In addition, it will also be possible to enhance these service with active functionalities to control local power production structures (e.g., photovoltaic panels).

- Smart Parking:

Road sensors that shows the best route to have access to a parking spot. Those sensor are connected to display along the whole main square. Indeed, its an impact of co2 reduction and on the traffic as well.

Besides, certain technologies like RFID and Near Field Communication (NFC) that works in a short range are possible to realize verification on the spots reserved.

- Automation and Salubrity of Public Buildings:

The last one and maybe the most conventional one that even not living in a smart city are easily to observed around are the sensors to control lights, temperature and humidity, controlling those in public areas around Padova, allow all the citizens to be feel more environmental concern and with the willing to help with the initiative of the government.

indeed, it is possible to enhance the level of comfort of the persons that live in these environments, which may also have a positive return in terms of productivity, while reducing the costs for heating/cooling.

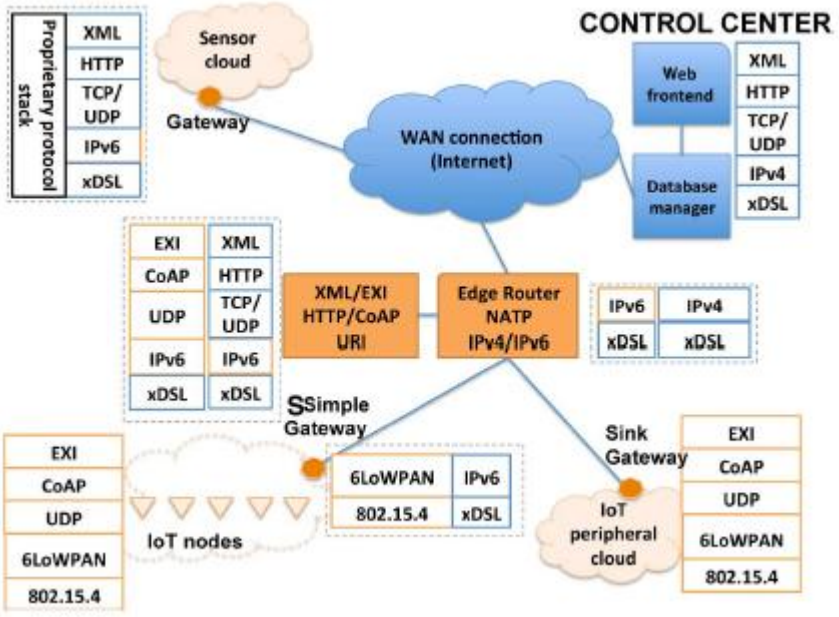


Figura 24: IoT developments for Padova Smart City.

12. OTHER TECHNOLOGIES RELATED WITH SMART CITIES

12.1 Definition of Internet of things

The Internet of Things (IoT) associated with the smartening process of a city, basically change the way of living of the citizens and the way of managing of the government, creating a different vision of the future, where devices, microcontrollers, are channels of digital communication that build a bridge for the users to be always in contact with the government.

The data generated for devices like home appliances, surveillance cameras, monitoring sensors, displays, and even vehicles, should be an important measure and an update and reliable information that will be useful for a quicker respond in the "taking decisions" action.

Therefore, the IoT technology try to cover all the different fields of every sector.

In all of this apply technologies such as home automation, industrial automation, medical aids, mobile healthcare, elderly assistance, intelligent energy management and smart grids, automotive, traffic management, and many others.

In summary, the smart city goal could be describe as finding the way to make easier the life of the citizens, and IoT is the first basic tool to achieve it.

Tracking the activity of the citizens, finding potential synergies between them, establishing a communication infrastructure that provides unified are the ways to pursue this objective.

The traditional life as it's known in term of public services, transport and parking, lighting, surveillance and maintenance of public areas, preservation of cultural heritage, garbage collection, salubrity of hospitals, and school.

This type of initiatives are particularly propel by the local and regional administrations that may become the early adopters of such technologies, thus acting as catalyzers for the adoption of the IoT paradigm on a wider scale.

Hence, the project go forward to the initial step that is finding the funds to start this type of developments at the internal of a community, and in this way some of the services that might be enabled by an urban IoT, and that are all of them part of the potential interest in the Smart City. Thus, it's possible to realize the win–win situation of increasing the quality and enhancing the services offered to the citizens while bringing an economical advantage for the city administration in terms of reduction of the operational costs.

The main barrier for this implementation is that the practical realization of most of such services is not hindered by technical issues, but rather by the lack of a widely accepted communication and service architecture that can abstract from the specific features of the single technologies and provide harmonized access to the services.

As was mentioned before, although in the IoT has many different standards, the implementation protocol is still the hardest part during the adoption, because it's not define one standard model that can be adopted for every type of smart community, however as will be shown in the Padova Smart city case in Italy, this paper will identify the main sectors for have the main impact of the IoT. [6]

The main standard can be seen in the next figure where it's the comparison from the unconstrained option that's the normal situation of heterogeneous technologies and common programation language, versus a connected and built integrated solutions that offer the IoT, mainly by a standard protocol for a smart city, understanding that without this types of development would not be possible to reach a high level of automation, independence and in that way a minimum level to be consider at least SMART.

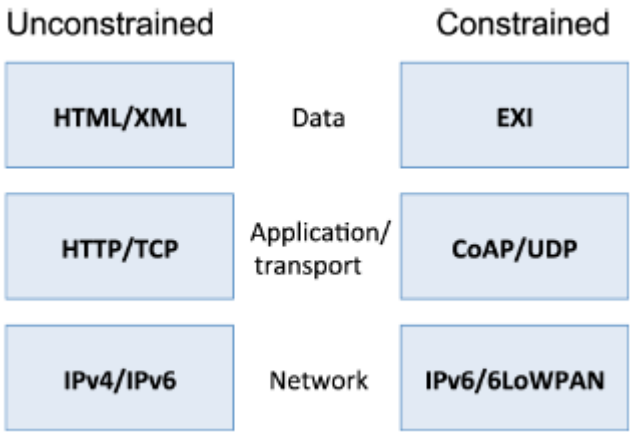


Figura 25: Protocols of the IoT for Smart cities

The first protocols consist in current standards of internet communication such as XML. And HTTP that in a simply language is transfer data method between a web browser and a web server.

Substantially, this figure above on the left shows how is the concept of normal networking transmission, and in the right side is the built as a set up network for IoT with a specific language for a precise devise or message.

These protocols are mirrored in the constrained protocol stack by their low-complexity counterparts.

A brief description of this type of language is going to be explain even if could be a step further from the topic because could be really detailing the explanation of the differences of the protocols. For instance the Efficient XML Interchange (EXI), the Constrained Application Protocol (CoAP), and 6LoWPAN, which are suitable even for very constrained devices. Meaning that basically the constrained protocols have already determined configuration for the devises that will be used. To explain better the figure above, should be seen each side as a cascade flow, where the step first is the type of language (DATA), and how to transfer it to the web server or network (TRANSPORT) and finally how it's the best practice to handle all that information gathered (NETWORK).

In the process of distinguish three distinct functional layers, namely Data, Application/ Transport, and Network, that may require dedicated entities to operate the transcoding between constrained and unconstrained formats and protocols. For this process its necessary to explain in detail how works the parts of the system different parts of the system. A briefly description of the 3 phases entering more in detail of the technologies will be done in the list below.

- Data Format

The data format is simply a semantic representation languages, where the XML is the one that is more common on the market. The problem with this type of information for the implantation and setup with certain devices is that the size of the messages is so large.

Instead, the EXI format is the new type o language that is more aligned with the new business model that have been trying to adapt for all the smart cities, which makes it possible even for very constrained devices to natively support and generate messages using an open data format compatible with XML.

Integration of multiple XML/EXI data sources into an IoT system can be obtained by using the databases typically created and maintained by high-level applications. In fact, IoT applications generally build a database of the nodes controlled by the application and, often, of the data generated by such nodes.

- Transport Layers

This step is how to transfer all the data gathered in the devices and with a standard language already selected. Most of the traffic that crosses the Internet nowadays is carried at the application layer by HTTP. However, this data transfer could be very complex for IoT devices. This complexity is one of the main factor of lower development on this field.

The CoAP protocol overcomes these difficulties serving a more liable service, transiting strictly the information required. The transition is not inmideately because its necessary an intermediary for the deployment from HTTP to CoAP, despite internet hosts can support CoAP.

- Network Layer:

The huge address space that is available in the IPv6 (network technology for IoT) helps to solve in a quicker way the addressing issues that are common in this type of development and implementation.

IPv4 is the leading addressing technology supported by Internet hosts.

In a Smart city one of the main factors is related to the huge number of user and a Network Address and Port Translation (NAPT) service currently supported in many LANs to provide Internet access to a number of hosts in a private network by sharing a common public IPv4 address, which is used to address the packets over the public Internet. The same technique can be used to map multiple IPv6 addresses into a single IPv4 public address, which allows the forwarding of the datagrams in the IPv4 network and its correct management at IPv4-only hosts.

Therefore, it's important to explain how to link Layer Technologies within the urban IoT systems, these bound will depend the successful link of information within the city.

The inherently large deployment area, requires a set of link layer technologies that can easily cover a wide geographical area and, at the same time, support a possibly large amount of traffic resulting from the aggregation of an extremely high number of smaller data flows.

This process normally is the first step into the real development of a Smart City, and take a longer time to be completely systemized. Seeing this implementation as the Phase 1 where a conventional city decides to move on towards the smartening process. For these reasons, link layer technologies enabling the realization of an urban IoT system are classified into unconstrained and constrained technologies.

The constrained as was said previously are development targeting the specific language and devices that are going to be involved in the smartening phase and transformation of the city. The constrained physical and link layer technologies are, instead, generally characterized by low energy consumption and relatively low transfer rates, typically smaller than 1Mbit/s. Bluetooth and RFID technologies are clearly common in this group.

The unconstrained instead are groups includes all the traditional LAN, MAN, and WAN communication technologies, such as Ethernet, WiFi, fiber optic, broadband Power Line Communication (PLC), and cellular technologies. The main features are generally characterized by high reliability, low latency, and high transfer rates (order of Mbit/s or higher), and due to their inherent complexity and energy consumption are generally not suitable for peripheral IoT nodes.

12.2 Devices of Smart cities

The present of devices around the city is a strong hint that an automation process is happening, indeed the city is entering in the smartening process. Apart of the languages of communication, the platform of analysis and the transfer mechanism, maybe the type of development that is the first step to start cataloging in a visible way for the citizens a city as a Smart one are the presence of devices doing routine jobs that previously did not exist or maybe was a tedious or manually job.

The type of devices that are commonly installed for the smartening process of a city are the next listed below, grouped for the main technologies on them.

- Backend Servers:

Type of devices that are located in the control center, are the “readers” of all the data that is gathered and stored, of course giving a added value as was suggested in the development of the IoT.

They are a fundamental component of an urban IoT where they can facilitate the access to the smart city services and open data through the legacy network infrastructure.

- Database management systems:

Due to the fact that all the information collected will have a higher frequency, it is necessary to have devices that allow the storage of it. These systems are in charge of storing the large amount of information produced by IoT peripheral nodes, such as sensors. Depending on the particular usage scenario, the load on these systems can be quite large, so that proper dimensioning of the backend system is required.

- Websites:

The main interaction between the citizens and the public authorities could be through an online website.

Enterprise resource planning systems (ERP): ERP components support a variety of business functions and are precious tools to manage the flow of information across a complex organization, such as a city administration. Interfacing ERP components with database management systems that collect the data generated by the IoT allows for a simpler management of the potentially massive amount of data gathered by the IoT, making it possible to separate the information flows based on their nature and relevance and easing the creation of new services.

- Gateways:

The gateways role’s is to interconnect the end devices to the main communication infrastructure of the system. The gateway task is the mapping the flow from the unconstrained- constrain protocol.

Gateway devices shall also provide the interconnection between unconstrained link layer technologies, mainly used in the core of the IoT network, and constrained technologies that, instead, provide connectivity among the IoT peripheral nodes.

- IoT Peripheral Nodes:

This is the botton of the common technologies for a IoT development, these devices are in charge of producing the data to be delivered to the control center, which are usually called IoT peripheral nodes or, more simply, IoT nodes. IoT nodes may be classified based on a wide number of characteristics, such as powering mode, networking role (relay or leaf), sensor/actuator equipment, and supported link layer technologies.

The R-Ftags or radio frequency tags, still have an important participation in the development of this smartening process, because their cost is lower comparing with other technologies and are so useful for the passive nature of the communication hardware.

Nowadays, the presence of different technologies that citizens are so familiarized with their use such as smart phones, tablet PCs, or laptops, may also be an important part of an urban IoT, providing other ways to interact with it.

The last generation of smart phones has a new integration program called NFC useful to tagged and identify objects and places, while the geolocation service provided by most common operating systems for mobile devices can enrich the context information associated to that object.

Besides, mobile devices are one of the most common tools that are an starting point for the IoT developments. Through an IP connection provided by the cellular data link service or setting up a direct connection with some objects by using short-range wireless technologies, such as Bluetooth Low Energy. Furthermore, it is possible to develop specific applications for mobile devices that can ease the interaction with the IoT objects, and with the system as a whole.

All the different cases and application of the different devices and digital communication will be shown in the Padova Smart city case, where order different technologies about transportation and energy efficiency will be included as well. [6]

12.3 BIG DATA smart city adaptation

The data gathered in a city it is not just enormous, it has the particularity that Is urban data, data for cities that are invariably tagged to space and time. This sort of data are largely being streamed from sensors, and this represents a sea change in the kinds of data that we have about what happens where and when in cities.

Starting for the definition of what is big data, and bringing an understandable concept for all the readers is without a technological description is “ any data that cannot fit into an

Excel spreadsheet". At the same time, the same description implies that some tools are required to the analysis and gathering process of it.

This implies, that big data is not a new concept but exists in every era where the tools for data processing are always being stretched by increasing size mainly for the increase in the frequency.

The concept of big data in a smart city concept is the product of multiple sensors that catch program and detail information automatically and routinely.

In fact, sensor technologies have become omnipresent with almost plug and play like qualities, thus enabling anyone to monitor and collect data from objects with motion that can be sensed by these devices.

Entering in the concept of big data for smart cities and smart communities, it is strictly necessary to measured in a certain way the impact of handling information, and apart of the reliability of it, another factor that have an important weight for it is the time. In overall cities have to rely on information for the transformation of itself from years and decades gathering that information.

The big data model for Urban transformation target to gather information in hours,of minutes and increasing in this way the level of reliability of it.

The fact that sensors creates an abundances of information in an automatic way, with information of localization, and in real time, create the need of develop different equipment to approach and use it, bringing certain value added.

The common data that is read for the sensors refers to transportation, energy, certain level of services, routes, financial markets and so on.

Traditional routine management of cities has been accomplished in ad hoc ways, not necessarily without any data or science but certainly without the kind of comprehensive theory and modeling that characterizes the longer term.

One of the main problematic of many cities is that the improvement projects are based on not reliable information, or at least not accurate, maybe because at the kick off moment is not precise anymore. Certain delays in many projects is mainly for the not evaluation of many variables that were not measured in the first instance. The disruptive model provide by big data instead, shows that projects can be run in shorter periods, with more reliable/real time information, having an overall vision of the total variables involved in the process.

The notion of disruption is all important as big data and the various tools that are being built as part of complexity theory, particularly those pertaining to networks, are being quickly fashioned to deal with how one can respond and plan for very short-term crises. These can range from those that beset the transport system to issues pertaining to the

housing market and the provision of social and other services. Meaning at the end that BIG DATA is pushing the city to short terms and quicker ways to achieve goals.

Clearly realize how the decision-making process change is the most challenging process of the implementation of the big data.

The transportation system is a clear example for the utility of big data in a smart city, and the strength to see problems, or even to adapt disruptive models.

The time period for the data is in average over 6 months during some data analysis about London will be provided to describe briefly the application of the big data in the smartening city process. Talking about the transportation card that its useful for all the transportation system of the city. About 85% of travelers use the card and immediately we have a problem of comprehensiveness in that those who do not use it are likely to be specialist groups – tourists, those who are occasional users, those who cannot afford the actual card and so on. The data set is remarkable in that we know where people enter the system and leave it, apart from about 10% of users who do not tap out due to open barriers.

The data set is thus further reduced in its comprehensiveness. This is possible by good estimation but requires us to augment and synthesize the data with other independent data sets, and thus there is always error. Such data are potentially extremely useful for figuring out disruptions on the system.

The fact that the transportation company needs to adopt certain hypothesis about the behavior of the citizens in the transportation system, clearly finishes affecting the level of accuracy of diverse projects launched. Following the example of London, and analyzing the infrastructure of the metro of the city that is extremely complicated geometrically, something that could help so much will be figure out how people navigate in it without assumptions, moreover, with real time data.

New users of the system will behave differently from seasoned users and this introduces further error. We can see disruption in the data by determining the times at which travelers enter and exit the system, but to really predict disruption on individual lines and in stations, it's necessary to match this demand data to the supply of vehicles and trains that comprise the system.

The fact that the transportation system can be track with a geo-positioning system make a big difference with the traditional model of the passengers waiting for buses/trains without the assurance of the arrival/waiting time.

Again, it is possible to make assumptions about passengers and their temporal positioning in the system, but no one has attempted this kind of synthesis. Currently what its able to do with the transportation data is assign it to lines and then to close stations and lines and figure out where passengers might divert to.

With this type of real information about the real behavior of the system is more feasible to adapt certain disruptive models, most of them are done to the network system without loading the passenger volumes, and so far, simple network analyses are all that is available for figuring out delays.

Even if certain situation regarding personal behaviors can occur inside the system like matching the demand data to the network is possible and is being attempted, but matching it with supply data is almost impossible. Diversion behavior of travelers is also tricky, for example try to analyze in the transportation system when people can walk between stations and bus stops, and there is considerable analysis needed to indicate how people might change mode of travel from one network to another – either for making a straightforward trip or a disrupted trip. These are massive challenges that will require new theories about how people behave in such situations at a very fine spatial scale. Big data is the perfect tool that provides the context for the study of this kind of short-term behavior.

12.4 Urban data platform

The only way to create a real community is establishing a communication between all of them, and a mechanism that allow to see and control progress and evolution. Besides, in a community that has a standard and unique way to communicate and constantly update is a reliable and transparent mechanism that increase the engagement of the citizens. Digital city data relating to, for example, administrative processes, urban construction projects or energy consumption of buildings is accumulated in large quantities. ICTs offer new potential for the dissemination and proper use of data, while an "Urban Data platform" offers the possibility of digital networking of various ICT solutions in urban areas.

The objective of this type of platform is that through the smart digital networking of public spaces is not only to improve accessibility, utilization or aesthetics of public spaces, but also help better understand the behavior of the people living in the city through collection of dynamic data (pedestrians, mobility behavior, environmental data, etc.). Continuous evaluation can serve as a basis for the further development of the smart networking of public spaces, in terms of meeting the needs of the city residents and increasing the attractiveness of public spaces.

This platform is developed for all the parts involved. Some of them could be:

Public administration (e.g. integrated urban development unit) for performance management. Companies active in the areas of transport, energy, project development, etc. for smart services and data collection

IT companies as a solution provider for smart services for data analysis platform and data collection components. Research partners to promote innovation in the area of integrated system components from data collection and smart services

In the next figure is shown the process of the creation of the unique and transparent communication channel.

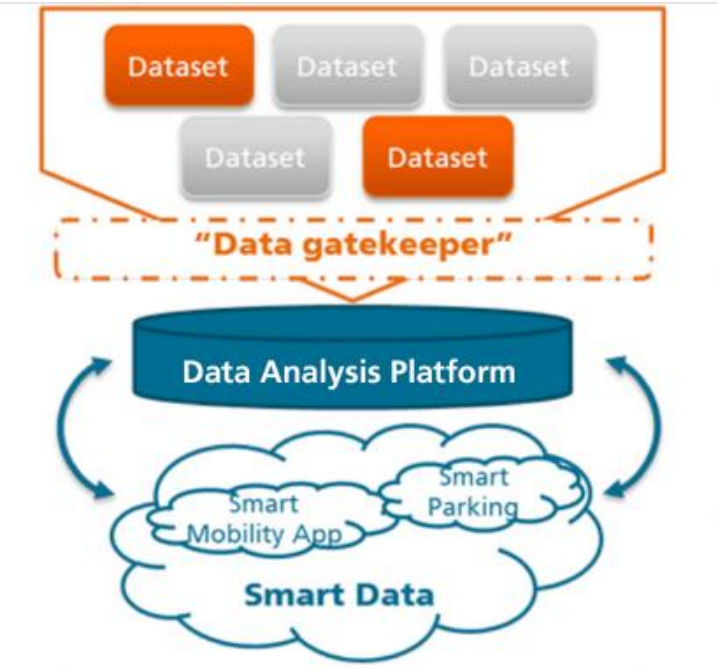


Figura 26: Smart data analysis

This figure shows all the topics that have an impact for all the community. Like a smart mobility app, rely on this type of models to be built.

Firstly, it's the gathering process and knowledge of the zone of influence. Afterwards is the so called Data gatekeeper that monitors the transfer of data to data analysis platforms, including all the privacy policies.

Without the correct analysis, data is just raw information. But mainly to make it live its necessary to create an important desire and interest from the community to use this platform and participate actively on it.

More advantages of this type of communication system are normally this one:

- Efficiency: Through data-driven decision-making, improved targeting of user groups and new potential for improved automation ICTs can significantly optimize processes.

New technologies Integrated ICT solutions can offer completely new approaches to address existing problems. Additionally, previously unknown problems are revealed and new solutions are provided to solve them.

- Growing demand: The advancing digitization of cities and regions also coincides with social change. In the last decade, a new "digital" generation of citizens who want new products and solutions that make their daily lives easier has emerged. Both companies and cities are adapting to the proliferation of ICTs and are aligning their products and services to meet the emerging demand.

- Modular offer: Cities can also cover specific areas and associated data and services (for example, through focusing on mobility services).

- Intermodal mobility system: Every smart community/cities are characterized for having a transportation smart system, or a plan to improve it, including components such as bike sharing, car sharing, public transport, intuitive booking and guidance systems, intelligent charging infrastructure, smart parking and new space utilization concepts.

The model mentions that this projects should be integrated by the government of the city involving the private companies that are part of it mainly in the area of transport, energy, real estate and IT.

Mobility revolution as part of the energy revolution, understanding transportation as the most visible and notorious impact on the basis of building an energy community.

An energy community needs to have a first fundamental transition from the urban energy systems, and in this road "mobility transition" is imminent.

A district with symptoms like congestion, climate change, local air pollution, is showing a big space for improving and the need to start adapting energy-urban transformation. The current dependence on motorized private transport made planners and researchers fundamentally rethink urban transport.

It's necessary to connect both sector understanding that by 2050, the energy consumption that belongs to transport should decrease almost in a 40% compared with the first decade of the two thousand.

Despite of the fact that the goal of this paper is not focusing on energy efficiency in transportation is necessary to overview it as a direct impact on the energy reduction/efficiency, as mostly because is the first presentation of a community that is cataloged as SMART.

The EU Commission has set the objective of phasing out fossil-fueled vehicles in cities by 2050. Cities like Oslo are trying to remove by 2020 personal motorized vehicles from the city center completely. At the municipal level, the urban mobility transition calls for a holistic approach including new models of urban development, combining compact urban development with mixed-use spaces, decentralized concentration, public-transport oriented urban development, inclusion and traffic safety.

It's relevant to mentioned that companies that participate in the transportation business can have relevant fixed cost buying the fleet, with the additional extra costs of the gasoline or diesel for the mobility. A kind of energy community was created between certain SMEs companies to find a common welfare was developing Shared E-Fleet. The implementation of this integrated cloud-based ICT solution for the intelligent operation of shared electric vehicle fleets between companies. The developed solutions are tested in several model tests at different locations under real conditions.

Involving more players in the initiative could impact reducing the first capex of all the companies, plus searching for more energy sustainable alternatives. And sharing a global welfare between all of them

13. CONCLUSIONS

The world is not anymore the place that we used to know. Nowadays, it is a puzzle that depending of where we are have different strategies to do it.

Starting with that premise that the world with the inclusion of the technology had a immeasurable change, it is necessary to figure out a new way to observe it, but mainly to live in it, in a way we get the same welfare that we as a citizens used to have. Working as an individual is not anymore a stereotype of being successful. The world is splitting in communities, that learn how to work together, be efficient together and have same goals and pursuit them as a unit.

Being part of a smart city or community is associate with using the technology immersed on it. Nonetheless, being part of it is more than that, means a commitment as a citizen, a desire to work for your community, a engagement to seek for the common goals.

Successful smart communities share in general a common structure, but to be efficient the people involved in it, should have the same interests and aims, that is the reason for neighborhoods and industries are the most common examples of smart communities. Furthermore, are people that have similar experiences, and opinion of the problematic that they should work on.

A smart community implies a new way of governance, but mainly a new way of communication, all the participants of it feel that are an important part of the growing dynamic of the community. The successful ones do not have barriers of communication and it flows in the same way when is coming from the upper part of the governance than when is coming from the bottom part, besides, the bottom part have more operating information and is always a positive feedback to the top level governance (Innova turin example).

Perhaps one of the concepts that is inherent during the whole thesis and not mentioned directly because could mean entering in a different topic is the one of the “cycle of the products”. The theory of circular economy is implied in the whole thesis as a model of survive and be more efficient with our world and environment. The fact that the energy should be seen as a controllable resource, that the waste could have a different ending, and that we all share this environment and it depends of us, completely change the perspective that this world is an unlimited resource.

Substantially, transform a city into a smart one, requires the adoption of a methodology, identify an approach, and this normally are not routed, and are not a model that fits exactly for every community. The fact that every community has different problematic, are located in different places, different companies and partners in the area with different interests, have people with different education and skills, ages, and other particularities,

make the possibility to establish a static model for a successful smart community really difficult.

The cases analyzed during the thesis show for instance that a smart community like the one mentioned in Bolzano due to the particularities of the weather, the climate, the agriculture and the companies surrounding focus the “smartening” process in energy renewable, and strong storage, new technologies for alpine sports, and pioneers strategies for different type of agriculture’s, than deal with low temperatures.

The case of Segrate instead, shows a different approach where is notorious that the smartening process is more focus on be part of a digital community, domotic implementation and high range of connectivity. The companies that participated in the project are aligned with the needs of the city, therefore, is a symbiotic relationship from the city and the companies that tackle in the project.

Milano Santa Giulia, follow a different approach because was more a rebuilding step of the neighborhood, meaning that a complete transformation of the physical structure was required. A community more focus on green environment, smart waste management, leisure, share mobility and working spaces, all of that allowing citizens to found in the neighborhood a place that have all what they could need.

Padova, it is an example of urban platforms, devices implementation around the city, management of Bigdata, digital transformation, variety in the communication with the city, and how all of them interact with the technology around the city.

Morgenstadt, instead follow the successful cases around the world and implemented them inside the city, approaching all the topics and targeting to solve all the problematic at the same time, a different vision that should be contemplated as a methodology as well.

Each city has their own priorities and their own approaches to find equilibrium and to move forward to a smart status quo. It does not mean that certain features were not similar, and at the end the general visions were pointing to the same target.

With the new technologies adopted for many of the communities mentioned before, resources such as energy, water, waste, air, etc, would not see in the same way. Depleting those resources is an activity that smart communities do not apply anymore. Instead, seeing them as a possibility to re inject them in a network and control more their production is the approach that should be follow.

In the energy field, technologies such as metering infrastructures, electric mobility, Smart houses, V2G, DER, completely modify the reality of the people that adopted them, and at the same time create conscience of the cycle of the resource and the fact that could be drastically optimized.

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