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The concept of “Smart City”, providing a the solution for making cities more efficient and sustainable has been quite popular in the policy field in recent years. In the contemporary debate, the concept of smart cities is related to the utilization of networked infrastructure to improve economic and political efficiency and enable social, cultural and urban development.

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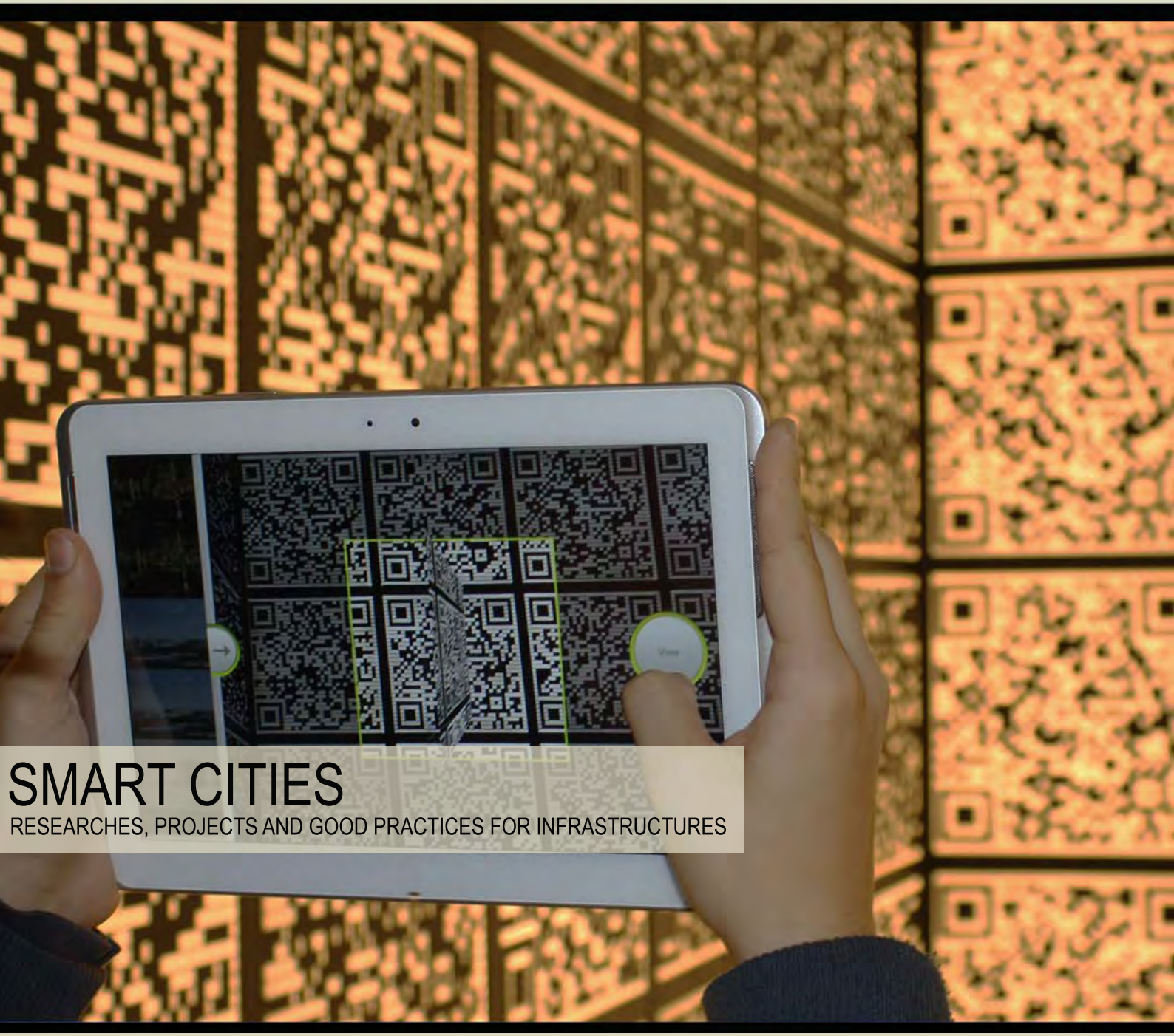

SMART CITIES

RESEARCHES, PROJECTS AND GOOD PRACTICES FOR INFRASTRUCTURES

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CITY AND ENERGY INFRASTRUCTURES BETWEEN ECONOMIC PROCESSES AND URBAN PLANNING

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ABSTRACT

The paper deals with the issues related to the relationship between city, energy, economic factors and city planning. These issues are analyzed from a theoretical point of view and are placed in a logical path based on three assumptions. The first considers the city as an intelligent system constantly evolving. The second considers the city as a system where economic processes come out at their highest level affecting other aspects of social and urban structure. The third considers the planning as the weak link in the process of urban development, one of the most exposed to economic and social pressures.

Energy production has experienced a great progress since steam and electricity were discovered. Each stage of this evolution has affected city and territory introducing significant physical signs, changing the ways of carrying out functions and creating new needs and new activities. The energy revolution, based on sustainable sources and on skillful management of the networks, will strongly affect the city and the way of organizing the activities, their location, dimension, and the shape of the spaces.

The paper explores some of the issues related to the relationship between urban system and energy.

The first section analyzes the meaning of the intelligent city as an entity that is constantly changing and constantly adapting. The second section analyzes the role of the energy systems in the evolution of the activities and of the city's image. The last section investigates the role of the economic factors in the evolution of the shape and meaning of city, pointing out that the way towards smart and green urban systems will largely depend on their economic advantage.

KEYWORDS:
City, Energy infrastructures, Economic factors, Urban planning

1 PAPER FRAMEWORK

The paper deals with the issues related to the relationship between city, energy, economic factors and city planning. These issues are analyzed from a theoretical point of view and are placed in a logical path based on three assumptions. The first considers the city as an intelligent system constantly evolving. The second considers the city as a system where economic processes come out at their highest level affecting other aspects of social and urban structure. The third considers the planning as the weak link in the process of urban development, one of the most exposed to economic and social pressures.

Energy, with its meanings and its implications, is used as the Ariadne's thread of the following analysis.

Energy production has experienced a great progress since steam and electricity were discovered. Each stage of this evolution has affected city and territory introducing significant physical signs, changing the ways of carrying out functions and creating new needs and new activities. From the night-light that has illuminated the cities to the factories that have blackened them, from the vehicles that have developed the communications to the traffic jams that have slowed down the cities, there are so many direct consequences related to the progress of the energy system.

The same energy revolution, based on sustainable sources and on skillful management of the networks, will strongly affect the city and the way of organizing the activities, their location, dimension, and the shape of the spaces.

This scenario is based on the observation of the city as intelligent system able to adapt to changes of all kinds, especially of economic and social nature. In this scenario the planning takes part only later, by regulating processes already under way.

The paper explores some of the issues related to the relationship between urban system and energy, focusing its attention on the city meant as intelligent system and on the energy meant as the engine of this system.

The first section analyzes the meaning of the intelligent city as an entity that is constantly changing and constantly adapting. The second section analyzes the role of the energy systems in the evolution of the activities and of the city's image. The last section investigates the role of the economic factors in the evolution of the shape and meaning of city, pointing out that the way towards smart and green urban systems will largely depend on their economic advantage.

2 THE CITY IS ALWAYS INTELLIGENT

A city is a physical, spatial structure. But its shape is not sufficient to describe the city, because it shows multidimensional characteristics, such as ecology, culture, technology, economy, society and other (Castells 1989, Hall 1998). The city as "system" was conceived more than 50 years ago: a group of elements that operate as a closer entity, on which planning exerts its command and control prompts (Berry 1964, Batty 2011). The city as complex system has been the next step, with the assumption that it does not automatically return to balance after a perturbation, like a simple system.

The transition from simple to complex system represents the passage from the city seen as machine towards to the city seen as an organism, with a biological transformation of the system based on a loop model instead of a linear model. The meaning is that the city does not work by means of input-output actions. The next step considers the city as «'complex adaptive systems' in which cities exhibit properties such as non-linear cause and effect relationships» (Eames, Dixon, May, Hunt 2013), with permeable boundaries allowing the passage of energy and of other vital elements (Rotmans 2006).

The above assumptions leads to suppose that the city is an intelligent structure (Lévy 1996), and that its intelligence should be assessed in an historical perspective and linked to the social, economic and political period under analysis.

The intelligence of the urban structures is a direct consequence of the city meant as holistic system (Cheli 2010). Generally speaking, the social systems are not the mere collection of individuals, but have holistic characters that make the molded organism more complex (Dubeski 2001). Applying the Durkheim's statement to the urban systems it is possible to state that the character called "intelligence" is one of the factors that goes over the simple sum of functions and activities contained in a city. The organizational level reached by the social capital, as defined by Putnam, adds to this system further weight and meanings (Trigilia 1999).

The urban systems, then, are more significant than the sum of their elements. The Roman city was intelligent for its historical moment, also because it was built by people endowed with great pragmatism and determination. The Italian Renaissance city was an example of great intelligence also because it was based on a strong concentration of wealth and on a steady cultural foundations. At the end of eighteenth century London and Paris were intelligent and changed the type on intelligence when, a few decades later, they were equipped with modern infrastructure such as aqueducts, sewers, subways. So they became worldwide economic and political capitols tanks to very determined and organized expansion's policies.

Fig. 1 – Interior of Cristal Palace, London, where in 1851 was held the Great Exibition

It follows that every city is intelligent, or rather it is intelligent in a different manner, in relation to the historical period we analyze.

If we look at the different stages of a city's evolution without considering an historical perspective, all the cities of the past seem unintelligent. Actually this view is wrong and leads to the significant logical error to consider the urban evolution as a random aggregative process, and not as the result of economic, social,

political, and thinking forces which act regularly on it and create communities that represent the highest level of civilization in a particular period.

Moreover, the city shows its intelligence favoring or penalizing the specific actions that the urban subjects have started. Not all the possible actions are also practicable and not all the activities carried out are concluded because, at that time, they may be neither feasible nor are necessary.

Actions, finally, need to be contextualized. Even if they can be categorized and typed, the ways in which they are carried out and their results are not necessarily are the same in different places. For example, the "western route to the urban transformation" affects urban areas through actions targeted to balance the current malfunctions, directing the cities to sustainability tracks. In this perspective the consumption of new soil is seen as a negative factor, while to act on the built city is a method of action that, if made in the right way, increases the urban resilience (Moccia 2013), reducing its environmental loads.

In newly developing country the situation is completely different. In fact, while they set up expensive initiatives targeted to carry out showcase-projects on sustainable urban systems, the simple transformation of the existing city still goes on as well as its expansion in an uncontrolled way, with a scarce – or completely absent – attention to the sustainability.

3 A NEW KIND OF INTELLIGENCE

The need to build urban systems with high sustainability and increasing resilience has had as crucial after-effect the diffusion of a specific meaning of the idea of intelligence. This meaning adds to the intrinsic intelligence of the cities a more material connotation. A universe of sensors and machines able to manage and optimize all the activities carried out by human beings, but also able to allow a potentially total control on people and on their freedom of action (Longo 2013).

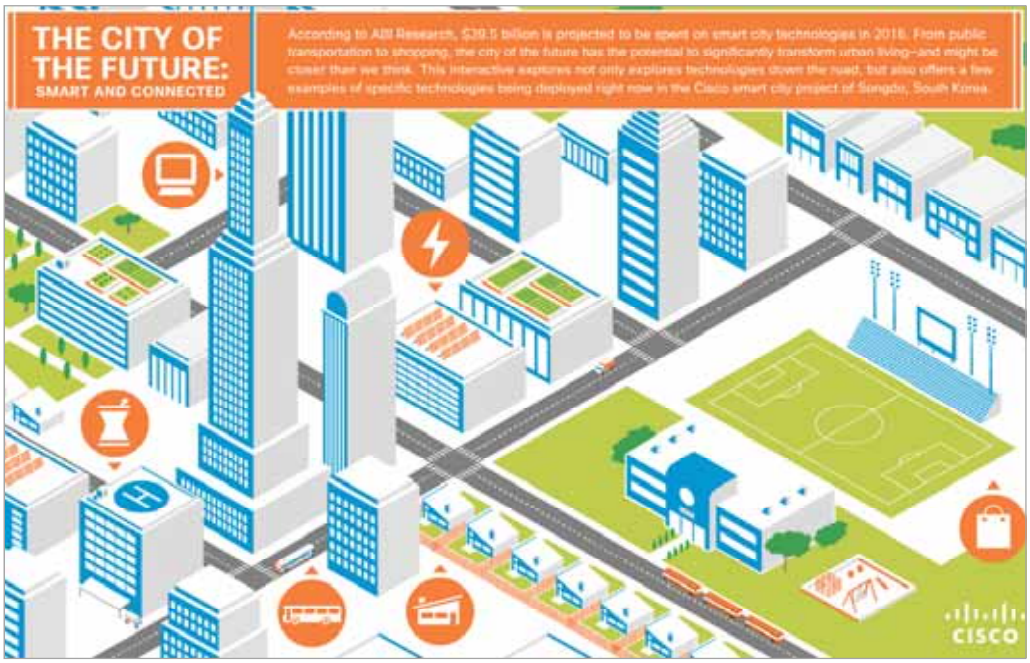

Fig. 2 – Cisco smart city project of Songdo, South Corea

A critical dimension of the cities is the growing supply of services, based on advanced and smart technologies meant «to integrate smartness in the infrastructure of the city so as to extend the effectiveness of the services at a lower cost» (Berthon, Guittat 2011).

The integration of infrastructural systems leads to the creation of an "intelligent infrastructure", able to handle large amounts of data, analyzing the trends, and acting accordingly by changing the service delivery.
A further level of intelligence is the one that overcomes the autonomy of the single infrastructural system reaching the coordinated management of many systems (energy, water, data, phone, ...) in an open, if possible, environment.
Starting from this meaning of "intelligence", being purely technical and perhaps even consumerist, the city becomes an object on which it is possible to apply economic models suitable to any commercial product. One of the most interesting model, applied to evaluate the evolution of the technology market, is the hype cycle model (Fenn, Raskino 2008). It hypothesizes that the emergence of any new product follows recurrent phases. The first phase creates strong expectations; the second is a phase of disenchantment, and only later there is the "enlightenment", phase in which that technology shows its effective potential.

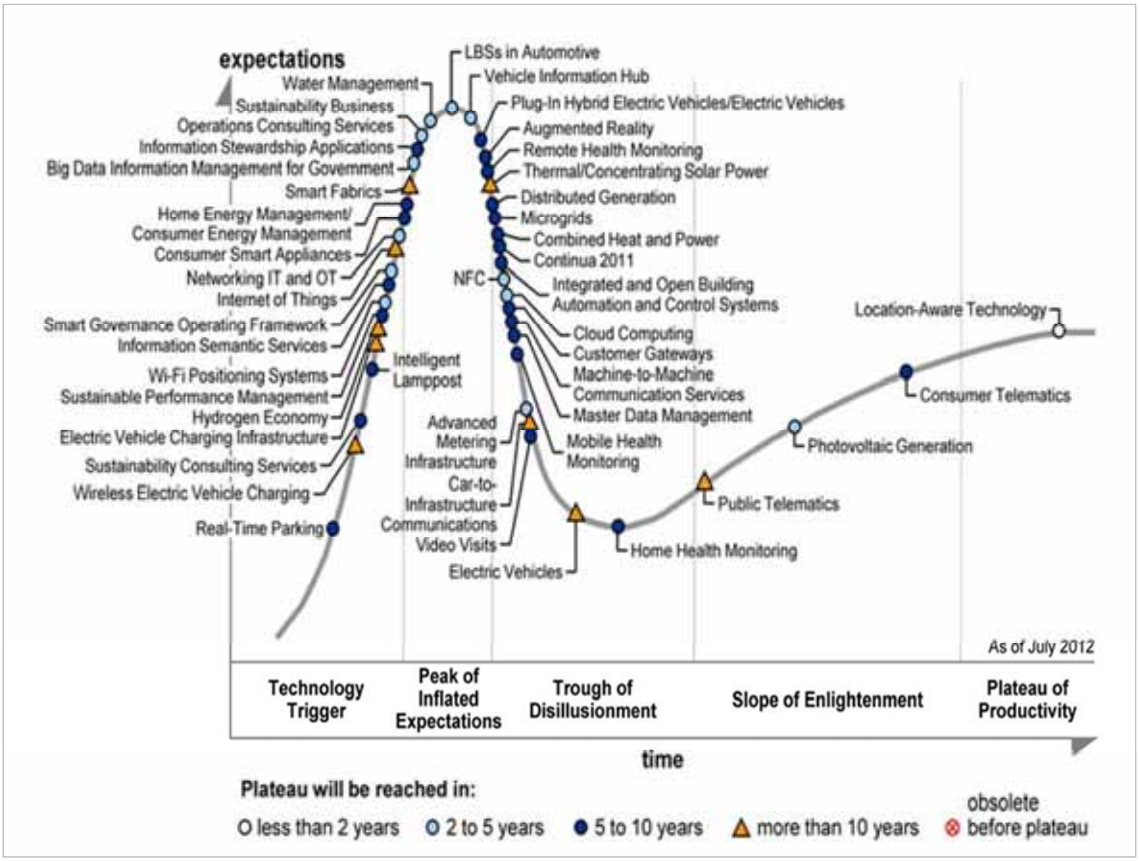

Fig. 3 – Hype cycle model

This trend can be applied in the case of "high intelligence" urban systems, normally defined in the literature as "smart city" (Papa, Gargiulo, Galderisi 2013; Fistola 2013).
At first, the neologism "smart city" was used to label ambitious plans for fully sustainable and computerized new towns, projects with a so high costs to curb the achievement. The disillusionment towards these adventures has prepared the ground to the third phase of the smart cities. It is based on an approach according which the cities develop sectorial projects creating a different way to access the services, which are addressed to an overall sustainability of the urban system and show a strong synergy among different subjects.

Therefore the cities are to revise their action, as, indeed, they have always done in the past. «All this suggests that the smart cities of the future will not be those created from the top down, but those that have grown organically more intelligent. Cities will not look very different from how they do today, but they will operate more efficiently thanks to the "data exhaust" they generate» (Siegele 2012).
From this assertion results the following consequence: as in the past, also in the future every city will evolve with its own characteristics, keeping and reproducing its specificities: in fact «every place is different. Every city, town or busy street is different from every other; often in many, important and significant ways. You can't just cut successful design or policy solutions from one place, paste them to another, and simply expect them to work like a dream. So you shouldn't. What you should do, instead, is to examine the conditions that made for success in the one place and try to work out if and how they can be replicated in your place» (Dales 2013).
Such considerations can be applied also, and above all, to the evolution of the energy systems that innervate the cities.

4 ENERGY DEMAND AND SUPPLY

Networks and infrastructure nodes represent the vital elements for the urban and territorial structures, because they make it possible to deliver the "oxygen" needed by the city, made up of energy, goods, and information. But also goods and information cannot circulate without energy.
For a long time the organization of the energy distribution has been essentially based on the purchase, on the international market, of the raw materials needed to meet domestic consumption, organizing consequently its production and distribution. In this phase «no one has ever asked if citizens did a reasonable and efficient use of energy, or not. It was made a 'supply programming policy', as called by technicians, without caring about teaching the consumers how to use only as much energy as it really needed» (Silvestrini 1980, 11).
Also thanks to this irresponsibility, energy consumptions have increased with remarkable rate over the years, with a growth that seemed unstoppable for a long time, up to the moment where the increase in the energy costs has become unsustainable.
From an economic point of view, the energy costs have a visible component – that is the cost of production, distribution and taxation – and an unseen component that strongly influences the first.
The visible costs of energy have grown significantly in the last thirty years. On January 1, 1980 a liter of diesel fuel was purchased at 0.12 Euros (250 Italian Liras), in the summer of 2013 the same liter of diesel costs 1.75 Euros. By comparison, a liter of bottled mineral water in 1980 was paid 0.20 Euros (more than diesel fuel), now 0.50 (one third of diesel fuel).
The strong increase in the price of oil has been the most significant factor relating to the increase in the price of fuel. The price of oil is a paradigmatic case of supply and demand. The supply has not increased in proportion to the growth in demand, driven worldwide because countries like China and India, as well as other developing countries, are strongly increasing their demand for petroleum.
This demand couples with the weakness of the dollar, which makes it worthwhile to invest (or to speculate) in commodities such as oil. These causes are pushing oil prices up.
Also the invisible component has affected this trend. This component is formed by at least three elements raining down on the final cost of energy products. The first is the critical condition of the environment in which we unload the wastes resulting from the combustion; the second is the undefined quantity of the row material reserves, in particular oil and coil (Maugeri 2013); the third is the geopolitical component, since the major energy reserves are often used as pressure instruments in the international policy.

The answer to this situation has been the variation of the national energy policies. This change of route has added to the supplies actions other actions concerning the demand, pointing out the negative consequences of an indiscriminate use of energy and the potentialities related to the processes of production and consumption from sustainable sources.

It is necessary, however, to act in this direction in a more effective way. If the progresses in the field of the sustainable and zero consumption building are evident, for example, the progresses in the field of the planning of urban areas and of mobility networks are less evident. As regards that, it could be useful to introduce specific evaluation systems for urban areas, targeted to achieve their sustainability certification, in the same way as for the buildings (Mazzeo 2013).

The need to work on this topic comes from the observation that, even in the most advanced cases of attention to urban sustainability, the action is still sectorial. If we analyze the case of Amsterdam, we can observe that the city is engaged in a set of sector programs characterized by high sustainability with the aim of reducing its environmental impact by increasing, at the same time, its national and international attractiveness (Berthon, Guittat 2011).

The overall programme has three primary objectives in the environmental field, as stated by the European Community regulations (EU 2007): reducing CO_2 emissions by 40% by 2025 compared to 1990; deriving 20% of the used energy from renewable sources by 2025; and achieving neutrality in terms of CO_2 emissions by 2015.

The achievement of these goals requires the interaction of different types of technologies and design methodologies (smart meters, electric vehicles, smart building design, ...) that can promote energy efficiency in different sectors. A special attention has been given to the electrical distribution, with a control center that manages the entire power grid, using information and communication technologies, and that provides more reliable, safe and economic electricity, with a smaller amount of emissions of carbon dioxide.

Nevertheless, even in the case of Amsterdam, the action towards a smarter city is carried out by sectorial technological projects and still does not develop actions in order to achieve a coordinate management of the activities, characteristic of the strategic and urban planning.

5 ENERGY AND INFRASTRUCTURES: A SCENERY FOR THE CITY OF TOMORROW

In September 2013 at the MAXXI of Rome the exhibition “Energy – Oil and post-oil architecture and grids” ended.

The exhibition was centered on the development of the Italian energy system after the World War II and its fundamental role in the industrial development. Through a photographic journey, it also analyzed the current landscape of the energy infrastructures in Italy. To complete the exhibition there were several suggestions and views for the near future city and territory, based on the passage from the oil to other, more sustainable, energy types and on their subsequent impact.

The examples that witnessed the history of the energy in Italy showed their ability to influence the urban landscape and the Italian landscape (Ciorra 2013): as striking example there were the highways and the support infrastructures as the “Autogrill”.

Fig. 4 – Oil and post-oil architecture and grids, MAXXI, Rome, March 22nd, September 29th Visions Section

What happened in the recent past allows us to assume that also the transition to other types of energy could have the same huge impact and promote the same alteration of image and meaning.

The question is not of minor importance: if we state that the energies of the future will be sustainable, it can easily supposed that the production modes and the distribution networks will have to change radically.

This line of thinking can be true both for the nodes of production and for the modes of supply of the energy needed for the urban functions and for the personal and collective vehicular travels.

The production of refined fuels is possible only in specialized factories, the refineries, large plants located in areas that can be easily reached from the oil fields. The distribution of refined products departs from these factories. This means that there are few areas where large plants with a continuous loop are gathered, from which the product is carried to smaller and diffused distribution nodes until reaching the final user.

The same occurs for the production of electric energy: a limited number of plants in which the productive cycle takes place, which from oil, natural gas, coal, water, or other source leads to the production of electrical energy, and from which the distribution grid that reaches home, factories, and offices starts.

The situation changes radically if we consider the energy produced by sun or by wind. Each point of a territory becomes a side suitable for production, distribution and consumption of energy. This does not affect the importance of the grids, especially in order to convey energy to the sites with high demand and to pass data and information (smart grid), but they will be accompanied by an increasingly high percentage of locally product energies (“zero distance” energy).

The above-said assumptions points out the need for optimizing the use of energy at all scales, from the building to the city. The production from renewable sources allows to reason not only in terms of “network”, but also in terms of “island”. This concept can be applied to the case of distributed and widespread production over an area. «Consumptions as much as possible on local level, storage capacity, energy islands that intersect with those nearby creating smart areas on regional level» (Cianciullo 2013).

Fig. 5 – Trento, Albere neighborhood. Project by Renzo Piano

In this perspective any road, building, neighborhood, public property become a potential location for the energy production, and the visible elements of these production's processes (wind turbines, solar panels, ...) will became integral elements of the urban and territorial landscape. In other words «the increasing use of new technologies in all the fields of collective life changes the behaviors, the social relationships and, then, the organizational forms of life. The change of the relationships among the social subjects tend to evolve into more and more complex forms that necessarily require a formal, functional and semantic re-design of the anthropic space at different scales, from the urban scale to the building/architectural scale» (Papa 1993).

If one of the challenges of the near future will be the management of an energy system characterized by a strong territorial continuity, both in production and in distribution, two are the lines of this management process. The first is the control of the introduction of new energy production systems in a largely man-made territory, where evident marks of stratified architectural presences are contained. The second, related to the previous one, is the regulation of the use of technologies for the production and the distribution.

The main feature of the regulations will be the flexibility. It is necessary because technologies change fast, sometimes faster than the context they operate in, so it will be necessary to avoid laws and regulations that can limit the realization of the projects, reducing the possibilities of development and their potential positive impacts.

6 ECONOMIC FACTORS AND URBAN EVOLUTION

The implementation of the above-shown scenario can greatly affect the image and the working of the city as it is today, and in the same way as any other economic and energetic revolution has done previously.

From the description of the scenario an important statement derives, namely that the true engine that causes the changes in the city is the pursuit of the utility in economic terms.

Many examples seem to go in the direction of this statement.

At the end of seventies London was a city affected by a heavy crisis (Thornley 1992). The inversion and the rebirth of the city occurred when the way of considering the role of the State changed, namely at the time when the neoliberal policies imposed an overhaul of Great Britain on basis far from those of the Labour

welfare. Just these policies have created the conditions for the rebirth of the city by encouraging the transfer of massive capital funds towards the city, which turned into investments, in creation of jobs and in redevelopment of whole urban sectors. The same strenght of the London Stock Exchange has encouraged the city giving it the role of primary node of the international financial exchanges.

Obviously, these processes have emphasized the income differences among social groups and the strengthening of the richer urban users, but this does not affect the leading role re-conquered by the city on global level.

Like other Chinese cities of the Eastern coast, in recent years Shanghai has been transformed in one of the driving areas of the China's economic development. This development, based on a pressing liberalization and on a stiff political control, had a significant impact on the form and on the metropolitan dimension of the city. It is in the Chinese cities – until the eighties made asleep by the ideological action of the Communist Party – that the same power has laid the basis for the radical economic change that has affected the country.

Also in this case there are negative implications. Among the others, the accelerated urbanization process that is blowing out all the Chinese megacities, and the high level of pollution in the urban areas (Mazzeo 2010).

From these examples it comes out that the assessment of the urban transformations are forced to deal with the economic factors that make them achievable.

The action of economic activities has been considered from Von Thünen onwards as the primary factor for the localization and development of urban centres (Grotewold 1959). Extending the reasoning it can be argued that the economic factors are the main cause of the urban phenomenon evolution, and their strength is so great that it prevails over most of the measures designed to regulate, including those implemented by planning.

Modern cities are shaped by economic factors that transform them, often to the point of distorting their structure and their shape. Structure and shape have remained unchanged only where the economic forces had been weak; and often these cities are dead cities or destined to this end.

In this context, the most recent scenarios consider the green economy and the smart economy as rapidly developing sectors (UNEP 2011; EEA 2013), for which it is conceivable that in the future these sectors could play an increasingly important role among the whole economic factors, becoming the driving forces able to shape and adapt the form and functions of the city.

As mentioned, these considerations overshadow the role of planning and require a review of its aims and its instruments.

Planning has often considered its work as predominant, and sometimes also in competition with the wealth-producer processes. Many planning theorists have thought the matter as an autonomous activity capable of creating an 'orderly and happy' urban structure.

The utopians such as Owen tried to draw urban structures in which production, dwelling, and services were present at the same time. Given the scarce results obtained and the condition of the cities after the industrial revolution, utopians have been replaced, on the one hand, by the planners associated with the established power, on the other hand, by the "militant" planners, who considered planning as one of the many variations of the political activity.

The current situation is clearly defined in the analyses of some sociologists. In the book *The Postmodern Condition* (1979), Jean-François Lyotard has analyzed the issue related to myths. Lyotard thought that the revolution of the eighteenth century have caused a complete dislocation of the mythical values, on which the existence of the society had been based up to that moment. «The modernity of the eighteenth century has

got rid of the myths of the origins (...) and has replaced them with the myths of the future (...), universalistic myths, which evoke the future of the humanity beings» (Augé 2005). Planning was an integral part of disciplines permeated with the myth of a better future also for the cities.

The transition from the modern to post-modern age is the time when these universalistic myths are thrown into crisis, causing the bitter fall of the illusions founded on the progress of humankind. And now that utopia has fallen, planning is naked in front of a reality most affected by economic factors.

To the emptiness left by the myth of the egalitarian society it has been tried to answer in different ways. Sustainability, participation, technological innovation, urban regeneration, ... are all strands where planning has tried to develop its action in absence of a recognized and original line of thinking.

To quote Baumann (2013), it is as if planning had entered in a fluid period of interregnum, in which the old rules (of any kind) don't work anymore and in which the new rules have not been invented yet, because there are ongoing changes without no reference points. This is equivalent to a state of crisis that «consists in the fact that the old dies and the new cannot be born», as Gramsci wrote (1975, Q. 3, § 34). Moreover, «in this interregnum most various pathological phenomena occur»: a state of crisis full of dangers but also full of new challenges for the city, for its managers and for its planners.

7 ELEMENTS FOR DISCUSSION

The need to reconsider the ways to produce and consume energy in the cities represents a challenge to the management of the urban systems.

Cities should aim at overturn their attitude to the energy problem: from simple consumer of resources and energy, they should become producer and consumer at the same time, finding internal production factors that would affect environment in lower percentage.

Here we want to sum up some discussion points contained in the paper, delving into the relationship between cities and energy infrastructures.

The starting point is the city meant as intelligent system. We have tried to show that, starting from the contributions coming from different research areas, there is a convergence of analysis that identifies an organizational intelligence in the urban structure. This intelligence adapts the urban evolution to the external environment, giving the city its own intrinsic degree of resilience.

This characteristic enables the city to adapt also to changes forced by critical processes of environmental involution, as long as all its components (physical, functional and anthropic components) are able to react in an effective and coordinated way.

In the last years the association of the word "smart" to the term "city" has extended. This association is a purely utilitarian expedient: smart city is not a more intelligent city, but a city more equipped with instruments intended to drive, or to address, specific moments of the daily life of citizens. It can be said that a smart city is a city where people have the possibility of being more stupid, since they have given part of their intelligence to external control and management systems.

In this context, the energy problem clearly shows the difference of approach between intelligent city and smart city. An intelligent city is a city that learns to produce and to consume on the basis of its needs, and that from this learning ability draws new elements for further reducing its waste of global resources. A merely "smart" city, indeed, is a city that adopt forefront technological tools allowing them to control the behaviors without learning from this process and improving its critical ability.

The present organization of the society plays an important role, in which economical and productive processes – targeted only to reach efficiency and profit – are fundamental. In this context, the green economy does not seem to be different from the previous economies.

Energy infrastructure, nodes and grids will become increasingly smart. We have replaced the incandescent lamps with low consumption and long life lamps, and then we have used the LED lamps and so on. We will replace the internal combustion engine car with an electrical car. paper will be replaced by files.
We will tend to consume less energy per unit of performed work. We will always be more "sustainable", but not because we are aware that it is necessary to be sustainable. On the contrary, we will do so only because research and industry will launch new products and applications able to perform higher efficient works, making the user believe that, even if the consumption level increases, the waste of the already scarce resources at his disposal decreases and, therefore, he is relieved of his responsibilities.
As Orazio wrote Orazio «Prudens futuri temporis exitum / Caliginosa nocte premit Deus» (Ode 3, 29). If "a prudent god hides the events of the future in a dark night", we cannot neglect the inscrutable that always exists when we reason about future scenarios, however satisfied with the progress done and however confident in the future.
Therefore we affirm that the city of the future will be as intelligent, sustainable and democratic as the present one and may be more than this, and the access to the energy will be one of the litmus tests of these evolutionary characters. On condition that you remember that the city, like society, is also deeply unfair. It is the place where the extremes co-exist, and these extremes, most likely, will tend to increase the distance between them in the future.
Machines and applications that run on more and more powerful networks will make this city over-connected and over-controlled. Poles, panels and green architectures will make it different from today. But, like today, it will be a place where the incongruous and the unpredictable will work alongside the rational and the planned, showing that the city is intelligent, then manageable but not so much.

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