Green Energy and Technology

Rocco Papa
Romano Fistola *Editors*

Smart Energy in the Smart City

Urban Planning for a Sustainable Future

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Preface

This collection of papers is about the energy dimension of a smart city. Its goal is to mark a boundary around the concept of “city smartness”, considered with regard to the energy issue and the town planning point of view. From another perspective, the aim of this collection of writings by the main Italian research groups in the field of urban sciences, is to define how the new concept of a smart city can successfully open a new understanding of urban systems and progress towards a new style of management for our metropolis.

If we have been able to see and participate in the smart city debate, one that has been spreading all over the world during the last 2 or 3 years, it is possible to argue that the main factors of this new concept regarding human settlements are energy and technology.

The technological dimension of the smart city movement is inherent to the city itself and represents the engine that moves the urban system in its spatial and temporal development. But today’s main issue is energy. Technology without energy is simply useless. It is no exaggeration to say that energy is the main challenge for the future of our cities as well as for human beings. At the same time, cities are the places where this challenge must be played out first, because cities are the main wasters of energy on the earth.

The planning of a smart city will be greatly different from the canonic urban planning of our current cities. Furthermore the energy dimension has to constitute the first issue to be considered in a new planning process. The new urban planning has to consider energy as a starting point and a goal to achieve, at the same time. Technology must be considered as a part of the planning process from the beginning. Technology, in order to know its needs, to understand and to drive urban system towards new, sustainable, and balanced conditions, has to be “adopted” and not merely “added to” the city, as we tend to do today.

Italy is a country particularly exposed to energetic problems for three main reasons:

- The geographic location of the country determines a particular vulnerability to climate change and consequently the need for large amounts of energy;
- The country has no primary energy resources available (Italy imports from abroad more than 80 % of its energy requirement);
- Due to a public referendum, no nuclear plant is available on national territory.

This study has an explicit concern about a city's energy. Again, energy has to be considered inside the urban planning process as well as inoculated within the new idea of a future city. We need new methods, new processes, and new tools to manage the urban system in order to drive it towards a smart dimension. From this concepts arises the idea of this volume which is structured along three main issues: the relationship between energy and city (in its different dimensions), a methodological aspect of energy's contribution to the urban system management, with a special focus about ontological issues, a review of case studies which describes some practices, procedures, and tools of urban planning. At the end this essay could be useful to students of urban planning, town planners, and researchers interested in understanding where the city of the future will go and what the energy contribution to this evolution will be.

The editors wish to express their gratitude to Springer for its professional assistance, and in particular to Mr. Pierpaolo Riva who has supported this publication.

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About the Editors

Rocco Papa has been Engineer, Full Professor of Land Use Planning at the Engineering Faculty—University of Naples Federico II since 1992. He has been Editor-in-Chief of the Scientific Journal TeMA—Land Use, Mobility and Environment since 2007. He was Director of the Department of Urban and Regional Planning of University of Naples Federico II, from 1999 to 2005. He was Chairman of the Urban Transformation Company Bagnolifutura S.p.A from 2006 to 2010. He was Vice-Mayor of the Municipality of Naples, from 2001 to 2006. He was City Councilor for Livability (appointed to Town Planning and Historical Centre) for the Naples Municipality, from 1997 to 2001. With the research activity carried out continuously since 1974, he has developed according to the following four main lines: the study of the interactions between urban and mobility systems; the management and governance of metropolitan areas; the safeguard of environmental quality in highly urbanized areas; the experimentation of new protocols for urban planning tools connected with the updating of techniques, methods and models of analyses, interpretation, planning and governance of territory. He has been scientific coordinator of many research projects: Research Unit of the RESIS Project 2004–2005 ~ Project of Research and Development for Seismology and Seismic Engineering; European Project 2004–2007 "Applied multi Risk Mapping of Natural Hazards for Impacts Assessments. Contract for "Specific Targeted Research or Innovation Project (STREP)—VI Framework Program"; Research Unit of the CIPE MURST Three-year (2000–2003); Project "The Protection of Seismic Risk: Vulnerability. Analysis and Requalification of Physical and Built Environment by Means of Innovating Techniques"; Research Unit of the National Priority Scientific Research Program 2002–2004 (Projects co-financed by MIUR) "The Safeguard Historical Cultural and Landscape Values in Italian Seismic Areas". He is the author of more than 100 publications.

Romano Fistola has been Architect, Associate Professor at the Department of Engineering of the University of Sannio since 2004. He was permanent researcher at the Institute of Planning and Land Management of the National Research Council of Italy (Naples) from 1996 to 2003 and member of the Scientific Committee. He was also a visiting researcher at the Center for Urban and Regional Development Studies (CURDS) of the University of Newcastle upon Tyne (UK), under the direction of Prof. J.B. Goddard. Since 2004 he has been teaching the courses “Town and Country Planning” and the course of “Management of the Urban Transformations” at the Department of Engineering of the University of Sannio. He was a coordinator and member of research teams in several research projects (national and international) in the field of urban and regional planning. The main scientific topics of his researches are as follows: New technologies and the city, smart cities, complex urban systems, GIS, urban risk, and sustainable cities. He was elected a member of the Board of the Italian Regional Science Association (AISRe) and is currently a member of the Italian National Institute of Urban Planning. Since 2007 he has been the editor of the Scientific Journal TeMA—Land Use, Mobility and Environment. He is author of more than 100 papers published in national and international books and journals.

City SmartNESS: the Energy Dimension of the Urban System

Rosaria Battarra, Romano Fistola and Rosa Anna La Rocca

Abstract This paper proposes a re-thought of the concept of urban smartness, particularly referring to the energy component. Recognizing that the new technologies, which are the most popular aspect of smartness, can play a fundamental role in the new approach, it has been suggested that we consider them in an adoptive way rather than in an adjunctive way, as it is commonly intended in the general sense of a smart city. According to this vision, in the first part of the paper, a new concept of smartness is proposed (SmartNESS: Smart New Energy Saving System). This concept is also related to the possibility of identifying some leading urban functions that can play a strategic role in improving urban smartness. In this sense, in the second part, tourism is considered as a drive function able to make cities more efficient and attractive if it will be integrated inside the urban governance process. The third part of the paper highlights how the rationalization and reduction of energy consumption is one of the essential fields to rely on in order to improve the smartness of a city. This part provides an overview of the most significant initiatives that are being developed on energy efficiency, and investigates some cases particularly innovative addressing the issue with an integrated and non-sectorial approach. Through the analyzed experiences, some possible intervention strategies to integrate the issues of energy efficiency in urban planning are suggested in the conclusive part of the paper.

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1 The City: a Complex, Dynamic, Energy-Intensive System

The debate about the smart city needs a theoretical structure that seems to be difficult to frame (Papa et al. 2013). This approach has to be built in connection with the up-dated theories of urban science and has to be able to describe the new urban phenomena.

Energy and technology are actually the engines of the smart dimension of a city where it is necessary to save energy using new technologies. But first it is necessary to find a way to figure out the parts and interactions among parts inside a city in order to understand how to operate with an effective energy saving.

The first study about a city as a system was made around the Sixties, but actually this paradigm seems to be still today the best way to model urban phenomena.

In 1964, Berry published his famous book: "Cities as a system within systems of cities" (Berry 1964) in which the city is considered as a territorial system. Four years later, Ludwig von Bertalanffy published his seminal volume: "General System Theory" (von Bertalanffy 1968) to whom Berry referred a large amount of its work on this topic.

Considering these first studies, the systemic approach to city interpretation has been deeply developed by a number of urban scientists that have identified subsystems inside the urban system. Therefore, we can assume that urban subsystems are the best targets for driving the energy saving action of the city. In other words we want to prove the hypothesis regarding the possibility of saving urban energy by acting on the urban sub-systems directly. This is possible in two ways: by reducing the urban entropy (first) and by influencing the social system trying to develop new behaviors. Considering the systemic approach for city analysis and the complex theory as well, it is possible to find an interesting new way to understand the behavior of the urban system and its trend of evolution.

Understanding urban complexity seems to be the most interesting field of research that has emerged in urban disciplines that seem to be slow in developing new paradigms of interpretation (Wallot and Gurr 2014, Mobus and Kalton 2015). In order to discompose the urban system, we can consider many urban subsystems. It is quite difficult to find a rule to understand how to define an urban subsystem. In general, we have to consider that a system has a geometry, composed of elements and relationships among them. However, the rule of geometry may not always be verified. It is surely verified if we consider the generative subsystem of the city: the geo-morphological and the socio-anthropic one. The geo-morphologic subsystem, as a whole, could represent the environmental support to the human settlement and territorial clusters and physical connections among them that compose it; the socio-anthropic subsystem contains the set made by men and human relationships. In order to identify other subsystems, we can consider the systems generated by the main one and define a sort of "dendrogram rule".

From the two main subsystems, it is possible to derive some other urban subsystems. Starting from a geo-morphologic subsystem, we can identify a physical subsystem, made by the material part of the city; as well as starting from the socio-anthropic subsystem we can identify the functional subsystem, made by human activities. Following this rule, we can identify different subsystems inside the principal ones. For instance, inside the functional subsystem, it is possible to find as many subsystems as the urban activities are: the residential subsystem, the economic subsystem, the education subsystem, the health subsystem and so on.

Urban mobility represents a special subsystem because it is not located in a single site of the urban system but is articulated across the urban space. This subsystem is vital for the city. Some other cross-subsystems act as a sort of connection between two or more subsystems. The psycho-perceptive subsystem, made by the perception that city users have of urban space ("the image of the city" according to the Kevin Linch theory, Lynch 1960) is a bridge between the socio-anthropic and the physical subsystem; also the economic subsystem acts as a connection among many subsystems: socio-anthropic, functional, mobility, etc. All the urban subsystems are elements of the urban system themselves, in a holistic view of the city. At the end, we can imagine the urban system, made by all the subsystems that interact with each other in order to move the system ahead, following its trend of evolution. This moving is supported by energy (coming from natural resources) that the urban system utilizes in order to evolve and to go on. The system evolves throughout space and time by means of energy. The hypothesis is to try to reduce the consumption of energy and its waste byproducts during the development of the system, in other words try to reduce the entropy. So Smartness is related to the reduction of urban entropy.

2 Defining Urban SmartNESS (New Energy Saving System)

Considering the previous formulated hypothesis, it is possible to distinguish two different entropies inside the urban system: an entropy of evolution and an entropy of development. The first one is due to the operation of the system itself and to the interactions among the subsystems. The second is related to the use of energy because of the needs of the system to go ahead along its trend during time. The two entropies are strongly correlated because when the evolving entropy's value is low, this means that the system utilizes the resources in a right way, saving a large part of energy. In this case, the system goes on thanks to this energy that can be used for the development process (Fig. 1). In some way, the two energies are connected to the external and internal complexity described by Jorge Jost (Jost 2004).

In other words, an urban system where the evolving entropy's value is high has no possibility to go ahead along its path of development. So it is possible to say that urban smartness is related to a low level of entropy of evolution and consequently to the possibility of the system going ahead saving energy. Another consideration can be developed about the entropy of evolution: when a system uses energy in a

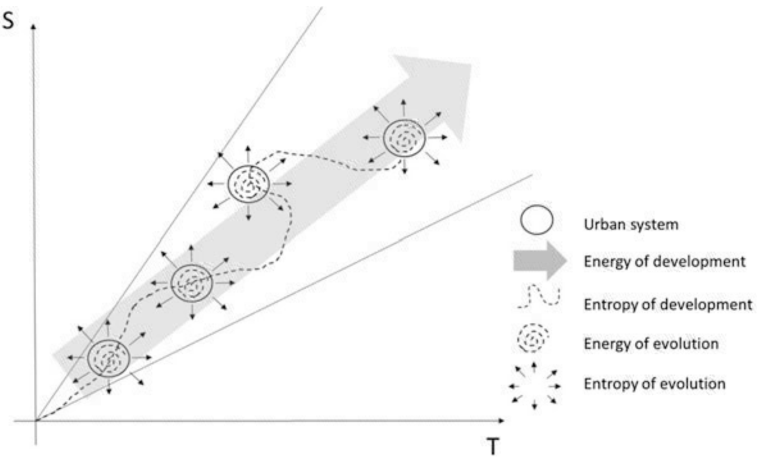

Fig. 1 The trend of the urban system with the energy of evolution conceptualized as a spiral force and the energy of development as a random path moving inside time and space

correct way, avoiding energy waste, this means that the cycle of inside energy of the system is closed. On the contrary, when within the different subsystems, discrepancies occur, these act like points of energy wasting: the cycle breaks down itself and a part of energy is dissipated (Fistola 2012). At the end, it is possible to argue that in an urban system the entropy is inversely related to smartness and moreover that a city with a number of malfunctions, inside the different subsystems (physical, functional, social and so on), cannot be “smart”. To bind together these concepts into one, it is possible to say that the real smart city is that one where the urban energy is inside an harmonic-closed circle, correctly used and saved, like in all balanced natural processes (Commoner 1971). Moving from these hypotheses we can find a new syncretic word which is a newly composed acronym: SmartNESS (Smart New Energy Saving System).

Urban SmartNESS is a concept that attempts to link the systemic approach to a need to guide the development of the city towards sustainable configurations characterized by an appropriate and innovative use of energy. The possibility of reducing the entropy of evolution is related to the capability of identifying the causes of malfunction inside different subsystems. In order to improve urban SmartNESS, actions and policies first of all have to identify all the discrepancies existing inside the urban subsystems and try to solve them. In this way, a lot of energy will be saved and the interaction among urban subsystems will transmit a new level of the urban system. The dyscrasias inside the subsystems are the wasting points of energy (resources) and the sources of entropy. This entropy has to be reduced. An example is the socio-anthropic subsystem in which the reduction of entropy is connected to the growing of social capital, an implementation of citizenship (Carta 2014) that produces, as externality, a correct use and a saving of energy within the city.

3 New Technology for Urban SmartNESS: Adoption Versus Adjunction

Urban SmartNESS could be achieved through a new way to use new technology. What it is necessary to clarify is that the innovation, communication technology (ICT) could be a strategic factor in order to activate the process of entropy mitigation inside the urban subsystems. In other words, the ICT have to be considered as an internal element useful to mitigate energy wasting and able to allow a real-time monitoring of the development of an urban system. Moreover, the new technologies, which are the most popular aspect of the smartness, can play a fundamental role in the new approach by considering them in an "adoptive" way and not in an "adjunctive" way, as it is commonly intended in the concept of a smart city.

Nowadays the ICT seems to be an external element (maybe just a showcase element) to classify "smart" a specific human settlement. If the city is equipped with a technological system for traffic control or for air pollution monitoring, it is quickly considered, or worst classified, as a "smart city", even if the buildings are crumbling, the social conflict is high and the queue at the post office is endless.

On the contrary, we want to state that "smartness" is related first to a low level of entropy that can be achieved through a technological adoption rather than a technological adjunction.

Urban smartness (referred to technology) is represented by the capability of the urban system of collecting, transmitting, elaborating and adopting information and data about its states, the active phenomena, the energy flows and physical flows, the intensity of activities and so on. In another words, "smartness" is not just related to the capability of the city to collect and store data but, actually, to the possibility of elaborating and using these data (big data) in order to activate a new organization of the system itself and minimize entropy. This condition (the minimization of entropy) makes a city smarter (Fistola and La Rocca 2013).

In a way, the Tower of Winds in Tokyo by the famous architect Toyo Ito (Fig. 2) could represent an effective example of this capability from an architectural point of view. This building was an element of an old aeration system located inside the district of Yokohama. Ito transformed the old building (located in the historical city) into a new piece of the city, able to catch information from its environment and transform it in light on its skin, with a continuous metamorphosis of its aspect (and role) inside the urban system. Data coming from the urban environment (noises, winds, etc.) are elaborated in order to activate different configurations of the building inside the urban system.

In this sense, it could be possible to say that smartness of a city is strictly connected to its capability of energy saving, in terms of entropy mitigation. In a smart city, the mitigation of entropy has to be a primary target and it can be achieved performing the following actions:

– minimizing entropy through the resolution of dyscrasias existing inside the urban system;

Fig. 2 The tower of winds in Yokohama by Toyo Ito

- minimizing entropy adopting new technologies to monitor and redefining the organization of the urban system;
- minimizing entropy by a saving use of urban energy in a general way (considering natural resources as energy for urban development) as well as in the specific behavior of daily life of inhabitants.
- minimizing entropy by considering a number of driving urban functions that can lead the urban system toward a new state characterized by a high level of energy saving and efficiency.

Furthermore, the new technologies, and in particular cloud computing, enable the creation of repositories of "dynamic knowledge" within which the by-products from the smart city are stored, processed, and reused, even for complex and composite urban systems within the government itself. Some urban functions can be identified to act as the driving function in new urban amenities; for such activities will be necessary to propose a redefinition and a systemic reorganization, including the use of new technologies.

Some recent urban operations seem to be going in this direction and represent interesting examples to analyze.

4 Tourism as a Driving Function

This part explores a specific aspect of analyzing urban tourism as a phenomenon that can affect the competitiveness and the overall well-being of the urban system. The condition to achieve this livability's objective can be identified in the need to integrate tourism development planning within the process of urban transformations' governance.

The key role of tourism for urban economies normally prevails on the impacts that it generates on urban environment, on the general organization of the city and on the socio-anthropic system in terms of conflicts between residents and tourists.

The tourism paradox really consists in the dichotomy of being at the same time a strategic factor for economic income[1]and a generator of negative impacts (overcrowding, pollution, noise, soil and energy consumption) on urban as well as at a larger scale on territorial systems.

The search for equilibrium between these two contrasting aspects must be the main target of urban and regional policies of development to both promote and protect territorial resources. This could be better understood if we referred to tourism as a system composed by its main components: the demand and the supply. Tourism demand concerns the needs expressed by a non-residential population; tourism supply refers to the presence in the city of facilities and structures to satisfy this demand. Town planning can influence the demand requests by intervening on the urban supply system in terms of quantity, distribution and qualities of facilities and structures able to assure efficiency of the city.

The question regards the necessity of defining tools, methods and conditions providing a qualified urban supply (of services, spaces and facilities) that has to be compatible with urban characteristics and resources. In this sense, tourism planning and land use are strictly connected and if properly planned, tourism can be a leading function to drive the urban system towards a "smart" dimension.

The emerging paradigm of the "smart city", in fact, could represent an opportunity to reconsider the current processes of urban planning, but it needs a holistic approach that goes beyond the one applied *per parts* that still seems to prevail in the articulation of its six components (economy, mobility, environment, people, living, governance). The numerous rankings, aimed at "measuring" urban smartness, seem to refer to the prevalence of one component over the others, failing to consider the city as a whole complex and dynamic system.

Urban promotion initiatives seem to concentrate mostly on city branding, rather than on the definition of strategies aimed at making cities able to support an additional urban load expressed by tourism demand; and urban "smartness" seems to be concentrated on the amount of apps available for the tourist use of the city. The application of new technologies, instead, should also strengthen the decisional role in defining adequate policies to manage urban tourism and to optimize availability of urban services and facilities.

The adoption of a systemic logic allows us to propose an innovative approach to the study of the effects of tourism on the organization of the city.

[1]The World Tourism Organization highlights that tourism has become one of the largest and fastest-growing economic sectors in the world. About 9 % of the Gross Domestic Product (GDP) comes from tourist activities (direct, indirect and induced) while its contribution to employment is estimated in the order of 7 % of the overall number of jobs worldwide (direct and indirect) and about 1.4 billion of US dollars come from tourism export market (UNWTO 2015).

As pervasive activity[2] where social components have a fundamental role, tourism can influence behaviors and play a driving role in promoting more sustainable use of cities and resources (decrease of waste production, reduction water and energy consumption, etc.).

In this vision, town planning has some responsibilities and needs a general renewal of its tools and procedures to drive the urban system towards compatible states of equilibrium characterized by appropriate and innovative use of resources, and energy in particular, promoting urban SmartNESS (Smart New Energy Saving System).

Referred to tourism, this condition could be represented by the integration between tourism development goals and urban planning targets. This integration would maximize positive aspects of tourism and minimize the impacts of the tourist phenomenon on the city's organization.

5 Urban Tourism from Entropy to Energy

Within urban system, tourism demand concentrates in time (holiday, big events, cultural exhibition, religious celebration) and in spaces that correspond to the areas where factors of attraction are located (monuments, museums, shopping, historical center, cathedrals, etc.). When urban tourism demand exceeds the threshold of the compatibility (with urban social, economic and environmental resources), the urban system collapses and levels of urban livability rapidly decrease. This vision can strictly be connected to the concept of "carring capacity". Referred to tourism carrying capacity can be defined as the ability of the urban system to perform tourist functions without threatening those that are essential for resident population (Thurot 1980; Mathesion and Wall 1982; Grasselli 1989).[3]

[2]In spite of global crisis, tourism has an uninterrupted growth over the past six decades. International tourist arrivals have increased from 25 million globally in 1950, to 278 million in 1980, 527 million in 1995, and 1133 million in 2014 (UNWTO 2015). At present, tourism involves all different social levels, being a cross activity, affecting several sectors (mobility, hospitality, leisure, etc.).

[3]Literature is copious about definitions of tourism carrying capacity (Maggi and Fredella 2010). Scholars agree about the complexity of the concept and refers to different components based on three main relationships:

- environmental: refers to the capacity of natural resources that are in de tourist destination and their fruition by tourists.
- cultural: refers to the tourists' satisfaction based on their expectation;
- socio-economic: concerns to the social and economic satisfaction of the residents referred to the presence of tourists in their city.

These relationship can be find into the definition by the UNWTO (1981) "the maximum number of people that may visit a tourist destination at the same time, without causing destruction of the physical, economic and socio-cultural environment and an unacceptable decrease in the quality of visitors' satisfaction".

The levels of crisis (entropy production[4]) arise when the urban system (physical, functional and socio-anthropic) is no more able to support the tourist load (the tourist demand). As we state in this study, there is a threshold (not necessarily numeric but that can be also virtual) that identifies the limit point (not to be crossed) beyond which the system falls in the area of the entropic production.

The balance between the tourist demand (growing and sector-based) and the urban supply corresponds to an "ideal value" (a state) that is difficult to achieve. However, we want to argue that by the planning of adequate actions and by the support of ICT it is possible to lead the system towards compatible states.

Tourism, being characterized by "transversality" and "pervasivity",[5] can be a driving function able to shift the system towards urban smartness conditions that necessarily engages physical, functional and social component of the urban system. In this sense, the "smartness" can identify a condition of possible equilibrium (between tourist demand and supply) where the city achieves widespread urban quality levels for all categories of users: residents, city users, and tourists.

The change that is characterizing the current tourist demand (from tourisms to "smart tourism")[6] denotes an improvement of tourist behaviors and consumptions, and promotes new models of use of the city according to a sustainability paradigm. Although sustainability in tourism is still an object of debate, at present, it refers to a new approach in tourist supply chain (transport, hospitality, entertainment) rather than to a tourist typology. The present tourist demand, on the other side, is more careful about environmental questions making sustainability a principle part of the factor that influences destination choices.

In this sense, the promotion of "sustainable destination" (i.e. zero emissions hotels, management and recycling of waste production; alternative energy applied to lighting of monumental areas and public building as well as to the private building sector, etc.) represents a factor of improving its attractiveness and competitiveness.[7] Energy saving, in particular, is the focus of the recent strategies to promote tourism development but it still lacks a holistic and strategic vision. Actions mainly concern the building scale (in this case the accommodation facilities) and refer to the use of new materials and systems to improve energy performance of the single edifice (lighting, water heating, ventilation). The measures

[4]In this study, entropy has been considered as a widespread negative condition of the urban system, which hinders the positive processes to achieve sustainability and tends to move the system towards trajectories totally different from those expected (see also Fistola and La Rocca 2013).

[5]Transversality refers to the multiplicity of sectors (public and private) involved in tourist development. Pervasivity refers both to the constant growth of tourism in the late sixty years and to the trend that characterizes actual demand, at all social levels, impatient of sharing its own experiences rapidly and in real time.

[6]Buhalis and Amaranggana (2014) defines the characteristics of a smart tourism destination referring also to tourists. A smart tourist profile is proposed in La Rocca (2014).

[7]Criteria for destination pointed out by the Global Sustainable Tourism Council propose and establish standards for sustainability in tourist destination recognizing tourism as a potent tool both for preserving resources and reduce poverty (see http://www.gstcouncil.org).

mainly concern the development of procedures to certify the sustainability of existing or new buildings also in accordance with the latest EU legislation[8] that promotes the "zero emission" concept also applied to the accommodation facilities. The hotel sector, after transport, in fact, represents one of the most energy intensive components in the tourist supply chain. Even though few studies exist about the assessment of hotels emissions and consumption, some valuations refer to a range of about 25–285 MJ/guest per night of energy use. In terms of emissions it has been estimated that a range of CO_2 production between <1 kg (in case of renewable energy use) and 125 kg (in case of self-supporting power generation) per guest-night (UNEP and UNWTO 2012). In Italy, the daily energy consumptions for the hotel sector (MJ/presences) are more about the quadruple one than the civil one (MJ/habitants) (ISPRA 2013). Nevertheless, at least as it concerns the Italian situation, there is still a lack of integration among different actors engaged in the promotion of new forms of sustainable supply services for tourism. The procedures for building sustainability licenses (residential, commercial, or tourist) based on voluntary mechanisms that are delegated to the individual initiative of the owners. ECOLABEL for example is the voluntary certification applied to the tourism sector for the acknowledgement of environmental sustainable criteria in the management or designing of tourist buildings. Ecological criteria for allocation of the mark regard the reduction of environmental impacts by the use of high levels of quality in services' supply and in the management of waste production. Even though the mark is considered as a factor of improving attractiveness of a destination, some research (ISPRA 2015), referring to the Italian situation, underline the lack of co-operation between private and public sector in supporting these initiatives in spite of a growing demand of greener structures. More than a third of tourists, in fact, declare it to be favorable to pay between 20 and 40 % more to spend their sojourn in a green accommodation (UNEP and UNWTO 2012). This aspect underlines both the change occurring in the present tourist demand (green tourism demand) and the high potentiality of tourism to affect social behaviors and lifestyles. In this sense, pervasivity refers to the growing trend to share opinion, sentiments and experiences in real time by using social networks (Facebook, Tweeter, Trip advisor, Google+, Istagram, etc.) and could represent a strategic factor to improve more sustainable forms of tourism demand. On the supply side, it contributes at activating new participatory planning processes where all the parts are involved (stakeholders, politicians, residents and tourists).

Tourism, then, is a favorite sector to test the real potentialities of the smart city approach. This regards not only the renewal of supply services by using new technologies, but also it needs co-operation among different actors (public-and private) and different levels (politic and administrative) involved in the implementation of the urban or territorial attractiveness (La Rocca 2014).

[8]The 2010 Energy Performance of Buildings Directive and the 2012 Energy Efficiency Directive.

6 Promoting, Managing and Using Tourism Inside the Smart City

The definition of smart tourism[9] has developed by analogy to that of a smart city and is equally undefined. The recent trends in defining smartness of a city highlight the key role of the social component (Ercole 2013) in the decisional processes and the active contribute of this component to promote more sustainable lifestyles and globally improve the quality of urban life. The relation between tourism and climate change has been the focus of Davos Declaration (2007) where, among others, there has been expressed both the exigency to convert the tourism sector towards a more sustainable growth[10] and the need of integrating tourism into the decisional processes at different scales to implement adaptation and mitigation strategies to face the present urban challenges.

If the role of tourism as a key sector is also able to implement knowledge and stimulate actions, that fact will come out in the framework of international policies; the arising concept of smart tourism seems to be much more connected to technology use and its applications (Buhalis and Amaranggana 2014). Indeed, technology has hardly contributed to the change of "tourism experience" becoming part of it both in the phase of planning and in the way of living and communicating it (Kim et al. 2008).

The term *prosumer* is recently increasingly used to describe the current tourist demand characterized by the ability to interact at any time and at any place as a result of new technologies (Web 2.0, social network, blog, chat, etc.).

Capability of managing, elaborating and sharing these information fluxes becomes strategically important not only to implement the attractiveness of a tourist destination but especially to implement the global planning process of urban supply, both private (tour operator and stakeholder) and public (administrator and politics decisors).

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[9]During the first Meeting of the UNWTO Tourism Resilience Committee, in 2009, Smart tourism has been defined as "*clean, green, ethical and quality at all levels of the service chain. A type of tourism able to satisfy the needs for the short-term responses to the economic crisis as well as those one of long term as sustainable development, poverty alleviation and mitigation climate change*".

[10]Referring to this issue in the premises of the document it is stated: the tourism sector must rapidly respond to climate change, within the evolving UN framework and progressively reduce its Greenhouse Gas (GHG) contribution if it is to grow in a sustainable manner. This will require action to: mitigate its GHG emissions, derived especially from transport and accommodation activities; adapt tourism businesses and destinations to changing climate conditions; apply existing and new technology to improve energy efficiency; secure financial resources to help poor regions and countries.

In this context, the smart tourist destination delineates a complex system where new technologies are incorporated in the process of its development and in the planning of tourism attractiveness (Wang et al. 2013; Buhalis and Amaranggana 2014).[11]

Referring to these definition and characteristics, new approaches are needed to facilitate co-creation among actors and co-operation among different institutional levels achieving smartness and competitiveness of a destination.

The priorities for the construction of a Smart Tourism Destinations (STD) refer: (1) to elements and conditions able to enhance tourists' travel experience; (2) to provide more intelligent platforms both to gather and distribute information within destinations; (3) to facilitate efficient allocation of tourism resources; (4) and to integrate tourism suppliers at both micro and macro levels aiming to ensure that benefit from this sector is well distributed to local society (Huang et al. 2012; Rong 2012).

The challenge that seems to be addressed to tourist cities concerns the capability to combine promotion objectives with the need of limiting consumption especially of energy and water, incorporating technologies inside the process of urban development and transformation. As we have stated in this part, tourism can be both a tool to activate new forms of sustainable facilities and feature, at the level of supply (involving private and public sector) and a mean able to affect social behaviors, at the level of the demand (social component). Tourism can be an occasion to promote the use of renewable energies acting as driving functions in the shift of urban system towards a smartness state.

The transition towards urban smartness involves, at least, four different levels/conditions that should interact each other's:

- knowledge sharing,
- integration between public and private sector (Stakeholder engagement),
- research involvement,
- integration between urban planning and tourism development.

As it concerns the first point, potentialities of a smart city approach mainly refers to the large disposability of data produced by technological sensors located inside the city able to measure in real time the efficiency of the physical component of the urban system. On the other side, within the city, the atrophic component, (that is resident population, city users, occasional visitors and tourists) can be considered as "alive sensors" (moving and using the city in different ways) able to share impressions and experiences.

Capability of processing, managing and interacting these flows of information represents the main challenge for the smart city approach (Fistola and La Rocca 2013). Tourism represents a valid area to test potentialities of knowledge-sharing mechanisms that, also by the involvement of users, could improve the urban

[11]Buhalis and Amaranggana (2014, p. 557): *Smart Tourism Destinations can be perceived as places utilizing the available technological tools and techniques to enable demand and supply to co-create value, pleasure, and experiences for the tourist and wealth, profit, and benefits for the organizations and the destination.*

supply systems of services and permit managing the organization of tourist flows inside the city.

Referring to the second point, the promotion of urban smartness as a global condition of urban livability needs a definition of governance processes based on co-operation among economic actors and political levels involved. The tourism sector involves a diverse range of actors and also for this “trasversality” it could act as a driving function to test the effects of actions based on private-public cooperation and improving their fulfillment.

The third point hightlight that the concept of a smart city still suffers from a certain discontinuity in the definition despite its widespread use. In this sense scientific research can contribute to define specific areas where a smart approach could be tested and applied. Mobility, behavioral practices and cycles of sustainable production represent some of the experimental areas where smartness could be better defined going beyond the techno-centric vision that actually still seems to prevail.

As it concerns the last point, we can state that within the present economic framework, tourism is one of the main factors of development that can improve the image of a city and its competitiveness. Tourism also generates impacts on environmental and urban systems affecting their equilibrium. The smart city approach might necessarily consider potentialities committed to urban development and tourist promotion according to the physical, functional and social aspects of the urban system. The impacts generated from a non-governed tourist development affect several aspects (economy, environment, social), they spread through different modes, and through different intensity; this variability can depend on the type of tourist activity, on the resilience of the cities and on the characteristics of the urban supply system composed of services and infrastructure to support tourism. City planning actions (intended as the search for an order according to a plan) should mostly focus on these aspects by a general renewal of tools and procedures of governance of urban transformations.

Some initiatives have been developed in Europe aimed at testing the integration among the four different levels above mentioned and improving urban smartness. The RENFORUS (Renewable Energy Futures for UNESCO Sites) initiative for instance, promotes projects of energy efficiency and the use of renewable energy in a selected number of UNESCO sites proposed as privileged observatories to test models of Sustainable Energy Communities to face global climate change effects. The energy transition from fossil fuel to renewable energy concerns the whole tourism delivery chain (transport, hospitality and leisure activities) creating new opportunities for business between the tourism industry, local communities and developers. Case studies refer to different scales, from buildings (monument) to Island, to cities and their historical center.

The case of a historic site is very significant especially for the restrictions these parts of the city are subjected to. The city of Edinburgh (UK) represents a best practice in Europe according to the national target of eradicating fuel poverty[12] by 2016. The Management Plan for the "Old and New Towns of Edinburgh" includes measures for energy savings through a partnership between Edinburgh World Heritage a not-profit organization for the management of the site, the City of Edinburgh Council and the Governmental Agency of Historic Scotland.

The Swedish isle of Gotland that, since the Nineties, started its energy policies to turn into a self-sustaining community based on the use of local resources and to be greenhouse gas emission neutral within one generation (20–30 years) represents another example of a sustainable community. Methodologies to involve resident population as well as tourists[13] has been adopted by municipalities to exercise a positive influence, disseminate a cultural model of energy consumption, and promote sustainable lifestyle models. Among its strategic objectives, in defining its Energy Plan to reduce the dependence by fossil energies, Municipality supports programs and projects aimed at defining conditions on how the supply of housing, workplaces, services and culture can be designed to reduce the need for car travel and improve the conditions for environmentally-compatible and re-source-economizing means of transport.

These examples and the above-mentioned considerations show how SmartNESS necessarily involves a review of the processes for the governance of the urban system.

Within this dimension, ITC technologies play a primary role that need to be supported, optimized, improved and integrated with city planning and urban government's processes.

The condition for the transition toward smartness refers to the adoption of technology rather than its addition inside the urban evolution process. By the use of ICTs technologies, residents, tourists and city-users can play a dynamic role in monitoring urban functioning permitting us to reduce the lack of efficiency if properly integrated with decisional levels that should be well structured to adopt and elaborate information into action plan.

7 Smart Cities and Energy Efficiency: a Winning Combination

Taking action to reduce the waste of energy, as already described, is essential for the purpose if increasing the SmartNESS of cities. What is more, the subject of energy efficiency, for some time, has been at the center of the strategies and policies

[12]In the UK a household is retained to be in 'fuel poverty' if it spends more than 10 % of its income on heating and power.

[13]The island passes from a population of about 65,000 inhabitants in winter to about 300,000 inhabitants in summer (Municipality of Gotland).

being developed by European cities, also in order to respond to the pressing demands from the European Union in recent years.

In fact the subject of energy, broken down into its various parts, (reducing emissions, using alternative sources, efficiency of distribution networks, and so on) has for some years now been at the centre of the agenda of the EU, which has fixed the strategies related to energy efficiency with a deadline of 2020 (Battarra 2014).

A thorough debate was started in 2014 in order to define the framework of the EU's energy and climate policies up to 2030. New goals were proposed for making the European energy system more competitive and sustainable by, *inter alia*, reducing emissions of greenhouse gas and increasing the use of energy from renewable sources. In particular, in October 2014 the European Council defined the framework for energy and climate policies with a deadline of 2030 and approved four objectives:

– reduction of emissions of greenhouse gas by at least 40 % before the end of 2030, compared to the 1990 levels (mandatory objective);
– consumption of at least 27 % renewable energy in 2030 (mandatory objective);
– improvement of energy efficiency by at least 27 % in 2030 (indicative objective);
– supporting the urgent completion, not later than 2020, of the domestic energy market, achieving the aim of 10 % for the existing electrical interconnections, particularly for the Baltic States and the Iberian peninsula, in order to achieve an aim of 15 % by 2030.

The EU strategy regarding energy is backed by the substantial investments that have also been planned for the 2014–2020 planning period, foreseeing an allocation of more than 17 thousand million euro (European Court of Auditors 2012).

Italy has also followed the policies of the European Commission by adopting a series of documents aimed at setting the aims with regard to energy saving and efficiency and the use of renewable sources. Lastly, the Italian Action Plan for Energy Efficiency (ENEA 2014) approved by the Minister of Economic Development in 2014[14] lays down the actions for achieving the aims fixed by the National Energy Strategy (Economic Development Ministry 2013) for achieving the decarbonisation of Italy in 2050.

For effectively dealing with the challenges in the field of the environment and energy and pursuing the Europe 2020 objectives, many cities are adopting the "smart city" model, which is characterised by the use of ICT and information flows, so as to guarantee careful development of natural resources, and is aimed at guaranteeing high standards of comfort and wellbeing for the community (Papa et al. 2015).

[14]Economic Development Min. Dec. 17 July 2014 Approval of the "Italian Action Plan for Energy Efficiency 2014" (Official Gazette 31 July 2014 no. 176).

Among the many and varied actions being taken by European cities in this field there is no doubt that the “Smart Environment” aspect is the one that attracts the greatest number of projects, research work and experiments in relation to the six characteristics that, according to established literature, define the Smart City (Giffinger et al. 2007). And it is also the one that best characterises the smart city and we can say that the minimum common denominator of smart cities is environmental sustainability broken down into its various parts (The European House 2012).

In the most common breakdown the Smart Environment aspect mainly includes projects aimed at improving energy efficiency on buildings and urban scale but also actions that use ICT for creating smart energy transportation networks and, more generally, for improving urban services, like in the case of innovative public lighting systems, and for reducing atmospheric pollution related to urban transport (European Parliament 2014).

Also in Italy, as shown by a recent experimental research on the subject of implementation of smart cities metropolitan cities,[15] the “environment” aspect is the one with the greatest number of activities. Out of a sample of about 1000 activities surveyed (researches, projects, technologies etc.), 30 % concern matters related to the environment (atmospheric pollution, solid urban waste, greenery etc.) and 25 % of them are aimed at the energy sector in the dual sense of energy saving and efficiency and the use of renewable sources.

Hereunder, to verify how the smart city model can be used for helping to increase SmartNESS, as already defined, we describe some activities being tried out in Europe and in Italy.

8 SmartNESS in Practice: an Overview

For a description of the actions and experiments regarding energy in progress in Europe and in Italy, a breakdown has been made into three macro-categories.

The first includes actions and projects in urban areas. In some cases districts are created *ex novo*, aimed at low energy consumption (“districts with almost 0 energy”) and equipped with a complete energy infrastructure (smart networks, alternative and renewable energies, water, and waste management), while in others the projects and actions concern the energy upgrading of existing districts where the buildings, mainly built during the seventies, have serious waste problems and low energy efficiency.

[15]The reference is to the “Smart Energy Master for energy management of territory” project that has been co-financed by the National Operational Programme for Research and Competitiveness 2007—2013 Smart Cities and Communities. The Environment Mobility Workshop of the Department of Civil, Building and Environmental Engineering of Federico II University of Naples drew up the project. For more details: http://smartenergymaster.unina.it/.

There are many actions in progress in Europe for both types of activity and some are well known (just think of the "historic" example of Freiburg), but other examples are Hamburg (HafenCity), Stockholm (Royal Seaport), Vienna (Aspern), etc.

In many cases there are complex activities of upgrading of districts, which not only deal with residential activities but foresee integrated strategies aimed at the development and attraction of new businesses (as in the case of Nordhavnen in Copenhagen), at the provision of services for the community, at the reorganization of the mobility system, and also include actions aimed at the efficient use of energy.

Among the most recent ones we would mention the vast project for upgrading the district of Hackbridge, a mainly residential suburb (with about 8,000 residents) located in the London Borough of Sutton, South West London. The district has various types of building, ranging from late nineteenth century cottages to terrace houses, and the local government has funded an urban restoration activity that includes actions aimed at energy-retrofit of the homes in order to reduce energy consumption and emissions of CO_2 (Deakin et al. 2014).

Many experiments being conducted in Italy are the result of participation by some cities in partnerships that, making use of funding by the European Commission, involve the implementation of pilot projects. Many of these experiments consist of the application of techniques and instruments for improving the energy performance of buildings that were not well built. This is the case of the R2 Cities and Energy Efficiency in Low Income Housing in the Mediterranean project (ELI_Med) being carried out in Genoa, or of European cities serving as Green Urban Gates towards Leadership in sustainable Energy (Eu-Gugle) in Milan.

As far as new projects are concerned, we mention EXPO 2015 in Milan which is intended—as is, of course, the nature of "universal exhibitions"—to be a kind of showcase of the most innovative solutions for creating a district with a low environmental impact. Great emphasis was therefore placed in the project on the adoption of Smart Grid and Energy Management System technological solutions, capable of guaranteeing performances with low energy consumption. In particular, the Energy Management System makes it possible to collect a large quantity of data (electricity consumption and production, presences, temperature, light etc.) in the cloud, process them and display them on an energy map of all the spaces and devices existing in the exhibition area with a view to not wasting energy, but also to "making the most of the unique opportunity offered by the Universal Exhibition, for broad involvement and for visibility, for spreading knowledge and for sharing more sustainable ideas and practices" (Expo Milano 2015 2014).

The second category, called "public services", includes very dissimilar projects that range from actions on network systems (water, energy, waste, etc.), to the adoption of innovative technologies for creating more efficient public lighting systems, but also to actions on particular types of public building (offices, schools etc.) mostly financed by substantial public funding.

In particular, a field of great activity of experimentation, especially with regard to energy aspects, is that related to the application of ICT to influence systems for management of energy distribution networks and also to make better use of renewable sources of energy.

As defined in the research by the European Parliament (2014), these are «ICT-enabled infrastructures to improve the management of utilities for a city, such as energy, water or electricity, e.g. smart power systems with intelligent management of energy mixes, smart grids, smart metering, heat storage, solar Energy management systems, and surveillance management systems for resources such as clean tap water or wastewater or heating efficiency systems.»

There are very many examples of these types of action in Europe and in Italy, even though in many cases they are still pilot actions applied on a small scale, mostly funded by private companies and firms that operate in the energy sector. By way of example, we mention here the Bremen Environmental Building Management project, Cologne ship-to-grid, Mannheim E Energy, Munich Smart Grid System, Vienna Citizens' Solar Power Plant, etc.

In Italy this category includes many activities aimed at reducing consumption with regard to public lighting systems and public buildings (schools and local government offices). For example, this is the case of the Milan project in Led or the New green NET and WEST (of Turin) Growing in Energy Efficiency Network project, which is aimed at improving the energy efficiency of public property and the public lighting systems of the municipalities belonging to the network (214 public buildings and 23,000 light points) but the project is still being finalised.

Lastly there is the category called "products/devices", which includes actions that foresee great use of technological innovation products for monitoring or controlling various aspects of the city: from traffic to environmental pollution, from electricity consumption to waste management. Generally these are projects developed by firms, which foresee the integration of various types of technology and networks of sensors and use large quantities of data. Cases of large-scale application are still fairly rare whereas there are many cases in Europe of application to pilot areas of the cities. Well known, for example is the Climate Street project in Amsterdam, implemented through a set of technologies that involve the use of: "smart meters", Energy Displays that give a feedback on energy consumption in real time and make it possible to save energy on the basis of the information supplied by the smart meter; an integrated system of low energy consumption street lighting by the use of energy-saving lamps that can be adjusted according to the light, solar panels for lighting up public transport stops, rubbish bins with compactors that make it possible to empty the bins five times more frequently, electric vehicles for rubbish collection etc. This action has been repeated in other European cities, like in the case of Smart Streets of Barcelona suburb Sant Cugat, and of Klima Strasse in Cologne.

In Italy also this category attracts a substantial number of projects, often financed by public funds and of a prototypal kind.

The last two categories of action in the Smart City field, either because of their experimental nature or because of the difficulty of producing them on a large scale, at least as far as Italy is concerned, are those that are less relevant for the purpose of the specific approach of this contribution which, as already mentioned, aims at describing integrated solutions that can influence the organisation of the urban system with a view to increasing the levels of SmartNESS.

9 Planning the SmartNESS: Some Guidelines

From the brief description of the most interesting experiments being carried out in some Italian and European cities we can draw some preliminary conclusions about how, in the light of the adoption of the systematic approach to studying urban phenomena, we can analyse the smart city paradigm.

Another important aspect that calls for careful consideration is if and how implementation of the smart city model can help to define strategies for the development and management of urban systems that increasingly have to deal with complex environmental challenges, the main ones being related to climate change and the need to reduce energy consumption drastically.

The experiments in progress that can be classified as "successful" took integration as their watchword: integration between different types of action but also integration between the different aspects of the city, from social to environmental, from economic to governance.

In particular, as it concerns energy aspects, the most effective actions in this sector refer to cities that are developing network actions, combining various components, bringing together the private sector (which produces innovations) and the public one, (which lays down the action strategies by drawing up plans and programmes), with the social one (for promoting virtuous lifestyles and behavior by the community). In fact, the cities that are leaders in the international classifications (Amsterdam. Copenhagen, Vienna) are the ones that successfully adopted these strategies decades ago.

In other words, a systematic approach to management of the city from a smart point of view calls for the promotion of integrated initiatives that go beyond the approach of sporadic and precise actions and that, learning from the best practices in Europe, succeed in reproducing and scaling actions taking the particular nature of the various urban and social contexts into account.