Smart City, Urban Performance and Energy

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Abstract Over the last few years there has been a growing demand for more liveable cities, and the notion of "urban smartness" is thus attracting the attention of both policy-makers and academicians. Among many different definitions, the "Smart City" by Giffinger et al. (2007), a functional model with six drivers of urban smartness (economy, environment, governance, living, mobility and people), appears as the most widely recognized. Within this context, increasing attention has been devoted to the "Energy" dimension concerning renewable energy, energy consumption, and energy policy. The present chapter reviews the theoretical and empirical literature on the relation between smartness and energy at the urban scale, specifically focusing on the 103 Italian NUTS3 province capitals. It mainly investigates how and to what extent the province capitals differ in terms of "energy" attributes. The chapter is structured into four sections. The introduction is followed by a literature review of the theoretical and empirical studies defining the concept of Smart City and its characteristics, with a specific focus on the "energy" role in a Smart City. Section three presents data and descriptive statistics exploring the role played by "energy" within the 103 Italian NUTS3 province capitals. The last section focuses on discussion and further research.

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1 Introduction

No doubt that the modern world is totally dependent on electricity, appliances and modern devices it powers; in particular, the supply precariousness, due to growing demand, global warming or peak oil, suggests the shift to renewable energy resources and energy-saving policies and behaviours.

Specifically, with the most of the population and activities concentrated, cities are the largest energy consumer (75 % of the world's energy), and produce 80 % of greenhouse gas emissions (UN 2009); besides, they are also expected to respond to global environmental concerns within tight financial constraints.

Within this context, increasing attention has been devoted to "Energy" concerning renewable energy, energy consumption and Energy Policy at the urban scale.

Actually, high density in the urbanized areas enhances new energetic strategies: (i) new and advanced building technologies to save energy demand and consumption, and to reduce the number of (polluting) power plants; (ii) urbanistic choices (Fistola 2013), which have to take into consideration urban morphology (Salat and Novacki 2010), and compactness (Yamagata and Hajime 2013); (iii) the use of light-emitting diode (LED) and renewable energy like solar and wind power for street lighting, and charging points for Electric Vehicles.

Besides, it is advocated that the environment has to be protected; therefore, new sources of available, diffused, and sustainable renewable energy are required. Furthermore, the traditional relation between the customer and the electricity grid is changing with the new idea of "prosumer", who creates goods for his/her own use and also possibly to sell (McLuhan and Nevitt 1972; Toffler 1980). Changes are also expected for distribution and power networks, which are transforming into an automated Smart Grid, using ICT for improving efficiency, reducing wastefulness, saving energy, and increasing the reliability and sustainability of the electricity's production and distribution (Smart Grid Insights 2014). The Intelligent Energy Europe (IEE) programme, consistent with the Europe 2020 strategy, aims to fulfil the following three main objectives: promoting energy efficiency and encouraging the rational use of energy sources; increasing the use of new and renewable energy sources as well as encouraging energy diversification; stimulating energy efficiency and renewable sources in the field of transport (EU 2012). A general objective (20 % reduction in greenhouse gas emissions, 20 % improvement in energy efficiency and 20 % of renewable in EU energy consumption) has thus been fixed by the European Union in the 2020 European Sustainable Strategy (COM 2010). European cities have thus to increase energy efficiency and decrease total energy consumption, while maintaining secure and continuous access to critical infrastructures like the electric power system (Morvaj et al. 2011). Within this context, urban sustainable development should be based not only on fairer prices, cleaner energy and greater security of supply, but also on different consumer choices (COM 2007). The big challenge to face is thus to combine global competitiveness and local sustainability (Lazaroiu and Roscia 2012). Actually, the cities labelled as *Smart City* (from now on SC) proved to be able to use ICTs to build and integrate

critical infrastructures and services (Nam and Pardo 2011). Therefore, it is interesting to explore the urban role of energy, in order to find a possible relationship between energy and smartness.

To this aim, in the present chapter, the 103 Italian NUTS3 province capitals are observed, using the six-dimensions of the "SC" Vienna model by Giffinger et al. (2007), and focusing on the energy indexes. A brief analysis of the evolution of the "SC" concept, which suggests a holistic approach to all the "good" characteristics of a city, introduces the literature on the theoretical models for assessing sustainability and smartness. A review of the empirical studies, considering indexes and indicators adopted for measuring urban success, follows. Since according to the empirical studies the "environment" dimension, which includes "Energy", does not seem to be a driver for urban success, a specific analysis has been carried out, focusing on the role of energy. Specifically, it is investigated how and to what extent the Italian province capitals differ in terms of "energy" attributes, starting from the results provided by Maltese et al. (2013) and Boscacci et al. (2014), which clustered them according to the SC model.

The chapter is structured into four sections. The introduction is followed by a literature review of the theoretical and empirical studies defining the concept and the characteristics of a SC, and the energy variables at the urban scale. Section three investigates differences and commonalities among the 103 Italian NUTS3 province capitals as concerns smartness and energy dimensions. Discussion and further research follow in the last section.

2 Literature Review: Smart City and Energy

2.1 The "Smart City": Theoretical Studies

Among the several definitions of a successful city, that of SC has now got the upper hand, thus attracting the attention of practitioners, policy-makers and academicians (Barca 2009; Barca and McCann 2011; COM 2012; McCann and Ortega-Argilés 2013). Table 1 shows the evolution of the label "successful city" in the last 25 years. Main authors are also indicated, together with the general focus and the different aim, which was supposed to be achieved. As it can be noticed, the original technological dimension has been enriched by quality of life and sustainability (Nam and Pardo 2011; Maltese et al. 2013). Specifically, after the many contributes on the "intelligent city" during the 90s, mainly dealing with ICTs as a key driver, the focus shifted to the "social" aspects of urban development: the higher productivity of a more educated human capital (Shapiro 2006; Winters 2011) and skilled workforces (Berry and Glaeser 2005; Glaeser and Berry 2006), or the triple-featured (tolerance, talent, technology) "creative city" (Florida 2002, 2005; Hall 2000). According to the sustainable approach to growth—considering the three aspects of Economy, Environment and Society—urban studies have flourished first in environmental and social fields (Inoguchi et al. 1999; Hollands 2008; O'Grady

Table 1 Labels for a "successful city"

Period	Authors	Focus	Label	Aim
90s	Mitchell (1995)	ICTs, digital networks	Intelligent, digital, wired	Efficiency
	UN-Habitat (1996), Inoguchi et al. (1999)	Environment	Sustainable	Efficiency
2000s	Shapiro (2006), Berry and Glaeser (2005), Glaeser and Berry (2006)	Human capital: education	Cultural	Efficiency
	Florida (2002, 2005), Hall (2000)	Human capital: creativity	Creative	Quality of life
	Anthopoulos and Fitsilis (2010), Carley et al. (2001)	Social capital: participation and e-governance	Smart	Quality of life
2012	Ratti (2012) (MIT)	Social capital: sensitiveness, adaptability	Senseable	Quality of life/efficiency

Source Authors' elaboration

and O'Hare 2012), and in the last few years—chiefly due to the global crisis—also in the economic one.

Even in the most recent definition of "senseable city" (Ratti 2012), a new path towards urban sustainability is suggested, which entails a deep use of new technologies for improving the quality of life (Ratti 2012; ABB & The European House-Ambrosetti 2012; Legambiente 2012), thus involving not only intelligence and innovation as means, but also inclusion and liveability as goals (Mitchell 1995, 2007; Sassen 2011).

Due to this comprehensive and multifaceted concept, a strict definition of SC is not easy; yet, some working definitions are anyhow available. Among these, the most widely recognized one states that a city is smart "*when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth, and a high quality of life, with a wise management of natural resources, through participatory governance*" (Caragliu et al. 2011). Indeed, sustainability seems the only common feature to all the feasible definitions of SC (ABB 2012), together with the target of "quality of life" (Legambiente 2012). As a conclusion, according to the majority of the theoretical studies on SCs, whatever the disciplinary approach or the research background (institutional, academic or entrepreneurial), it is possible to state that SC should pursue two main goals: full general sustainability and quality of life, which may be summed up in the concept of "smartness". Last but not least, due to their "wired" nature, which provides a great stock of data, SCs are expected to be easily analysed (Batty 2012). As a consequence, many empirical studies on SC have been carried on, not only by universities and private companies, but also by governmental institutions (COM 2012; MIUR 2012) in order to define the characteristics of a SC, which are presented in the next paragraph.

2.1.1 The Characteristics of a "Smart City"

The most of the empirical studies on successful cities fail to provide a holistic definition of SC and rather end up choosing indicators for the many dimensions; nevertheless, in some cases, useful research tool-frames have also been provided. A first example is represented by the Nijkamp Hexagon, which identifies six typologies of urban capitals for analysing the level of urban sustainability for a United Nations survey (Nijkamp et al. 1993; UN-Habitat 1996). More in depth, the Hexagon model involves six different typologies of capitals which are strongly interconnected: (i) the natural capital (Ecoware) that refers to environment, natural resources, landscape, energy consumption, waste management; (ii) the man-made capital (Hardware) including built environment, technologies, land use and functions, transport system; (iii) the economic and financial capital (Finware) that is sources of capital, both private and public, capability to attract investors, dynamism of economic system; (iv) the institutional capital (Orgware) that concerns policies, governance at local level and partnership or cooperation between public and private sector; (v) the human capital (Software) regarding investments in knowledge, education, training with the aim of promoting innovation and creativity; (vi) the social capital (Civicware) that pertains to intra- and inter-generational equity, stakeholders and community involvement and local quality of life. With reference to the conceptual framework suggested by this multidimensional model, it is clear that the level of sustainability depends on how many dimensions are considered, and on the degree of their mutual relationships, suggesting that effective appraisals of sustainability at the urban scale should be based on an integrated assessment (Ravetz 2000).

Similarly, although in a different business perspective, IBM suggests a research frame for studying urban success, according to which, cities can be seen as complex networks of the following components: citizens, businesses, transport, communications, public utilities (water and energy) and city services. Therefore, Intelligent Cities are those which better manage their stock of instrumentation, interconnection and intelligence (IBM 2009) by combining ICT with its physical infrastructure in order to improve the quality of life and to collect data to make better decisions and deploy resources effectively and efficiently (Kanter and Litow 2009; Hall et al. 2000).

Finally, the most valued description of the SC characteristics has been provided by the Technology Universities of Wien and Delft together with the Ljubljana University (hereinafter "The Vienna model"). According to this functional model, the drivers of urban smartness can be grouped into six "smart" dimensions (Giffinger et al. 2007). Furthermore, in the Vienna model, a working definition of SC is also provided: a SC is "well performing in a forward-looking way in six characteristics, built on the 'smart' combination of endowments and activities of self- decisive, independent and aware citizens" (*ibidem*, p. 11). Focusing on these dimensions, Smart Economy mainly concerns competitiveness; Smart People is about social and human capital; Smart Governance refers to participation; Smart

Table 2 Smart city dimensions in the literature

UN-Habitat (1996)	IBM (2009)	Vienna model (Giffinger 2007)
ECOware: natural capital	**Water/energy**	**SMART environment**
HARDware: hand-made capital	Transport	SMART mobility
FINware: economic and financial capital	Businesses	SMART economy
ORGware: institutional capital	City services	SMART governance
SOFTware: human capital	Citizens	SMART people
CIVICware: social capital	Communications	SMART living

Source Authors' elaboration

Mobility deals with both ICTs and transport; Smart Environment involves natural resources; Smart Living is a synonymous of quality of life.

It is worth noting that, although with small differences, the observed categories in the three models above-mentioned are quite similar, regardless of the field of study (Table 2). Due to this, from here on, the label "smart" will be used for indicating any kind of "successful" city.

In particular, energy management, which is specifically considered by IBM, is also observed in the natural capital (Ecoware) of the UN-habitat survey and in the Smart Environment dimension of the Vienna Model (Table 2, first row in bold).

2.2 Empirical Studies

Due to the complexity introduced by the need to make a city "smart", the importance of integrating technologies, systems, infrastructures, services, and capabilities (Jennings 2010) is well reflected in the indicators used for measuring the smartness itself. In particular, as concerns the empirical analysis on SCs, several studies have been conducted at both European and national scales, which can be grouped into two categories: (i) ranking analysis, that classifies cities according to selected indexes/indicators; (ii) more complex analysis (i.e. hedonic prices method, econometric models, and cluster analysis), which try to explain the reasons for success.

2.2.1 The Ranking Studies in Italy

Focusing on Italian cities, the ICity Rate report—where the "I" in the title of the report stands not only for Intelligent, but also for Innovative, Inclusive and Interacting—classifies the Italian NUTS3 province capitals according to the Vienna model dimensions, using about one hundred indicators at the local and provincial scales (Forum 2012) (Table 3). According to this ranking study, the most "intelligent" city is Bologna, which awarded one of the first six positions in all the

Table 3 The ranking studies

Report	Authors	Sample	(stated) Issue	Sources
ICity rate	Forum (2012)	103 province capitals	Intelligent cities	Various sources
Ecosistema Urbano	Legambiente (2012)	104 province capitals	Environmental quality	Istat, municipalities
La Dolce Vita	Colombo et al. (2012)	103 province capitals	Quality of life—real estate price, wages	Various sources

Source Authors' elaboration

dimensions, save for the environmental one (42nd position). Parma follows, with a good placement in four out of the six dimensions; even in this case, environment is less smart than that in the other cities (only 41st), together with the living quality (13th).

Another ranking for the same cities is provided by "La Dolce Vita" (Colombo et al. 2012, 2014), which considers urban quality of life using five framework dimensions (climate, environment, services, society and economy) (Table 3). The best performers show better results in the economy and services dimensions, rather than in those concerning the environment (with climate obviously privileging southern cities) or the society. As far as the geographical pattern is concerned, quality of life is highest in medium-sized towns in the Centre and in the North of Italy: Pisa, Trieste, and Ancona seem to be the best Italian cities to live in, followed by Bologna, Firenze, Pesaro and Venezia.

An additional suggestion can be inferred by the results of the above-mentioned rankings which seem to disregard the environment dimension. Within this context, no surprise, then, if the Intelligent Community Forum (ICF), in selecting 7 out of 21 Smart Communities every year in order to reward them, seeks for the highest scores in the following factors: broadband connectivity, knowledge workforce, digital inclusion, innovation, and marketing and advocacy.

The Environment is, instead, the focus of the Ecosistema Urbano' ranking, yearly edited by Legambiente, focusing on the environmental quality of the Italian NUTS3 province capitals (Table 3). In 2012, for example, the XIX Ecosistema Urbano considers 25 indexes measuring urban environmental performances regarding: air, water, energy and waste management, transport and mobility, green areas, environment, and mobility policies. The best cities present good results in the most of the indexes; among the others: waste management (share of recycled wastes), ciclability—which considers the urban "bike-friendliness" level, and sustainable mobility index—which encompasses broader and different aspects of urban mobility. Verbania proves to be the most "green-friendly" city, together with Belluno, Trento and Bolzano: as expected, the North of Italy shows the highest level of environmental concern.

2.2.2 Econometric and Statistical Studies

Switching to the studies based on statistical or econometric analysis (Table 4), Caragliu and Del Bo (2012) focus on the impact of smart characteristics on urban performance—measured by per capita GDP—and investigate this impact at the local level for a sample of 94 cities in 14 EU countries (1999–2006). They find that urban density is negatively associated to urban performance, while the smartness index is always positive and significant. Besides, cities specialized in industries with high-tech content, with higher amenities, and more attractive as concerns tourist inflows, are better performing.

Colombo et al. (2012, 2014) analyse, on one side, the relationship between quality of life and housing prices; on the other side, the link between quality of life and wages within the Italian province capitals in the 2001–2009 period. Quality of life is defined as the weighted average of a set of local amenities, branched into the five main domains described in Sect. 2.2.1. The result is that housing prices are higher in cities with less pollution, more green areas, located on the coast, with higher teacher-pupil ratio, better transport and cultural infrastructures, higher civic-ness, university enrolment, higher value added per capita and lower unemployment rate. On the other hand, housing prices are lower in those cities with higher crime rates and shares of foreigners.

The recent analysis conducted by Siemens-Anci on the largest 54 Italian province capitals, has grouped the cities by means of a Cluster Analysis on the basis of five synthetic indexes: urban environment (air quality, urban green, water and waste management), real estate stock, energy management, mobility, and health service supply (Siemens-ANCI 2012). Six clusters are found, and five of them are roughly corresponding to the five proposed indexes and present the highest scores for specific features. The left cluster of "becoming cities" (cluster 5) has got scores below average in each measure, but the commonality among the 10 cities of this group, which are small-sized and mainly located in the South, seems to be the growing specialization in one specific sector. The best cluster is the "Ideal Cities" (cluster 3), which is composed by 4 medium sized cities in the North-East of the country (Bergamo, Brescia, Padova and Trento), with the best scores in all the dimensions.

Table 4 Other studies

Authors	Sample	(stated) Issue	Methodology	Sources
Caragliu and Dal Bo (2012)	94 European cities	Smartness	OLS	Urban audit
Colombo et al. (2012)	103 Italian province capitals	Quality of life—real estate prices, wages	Hedonic prices + ranking	Various sources
Siemens-ANCI (2012)	54 Italian major cities	Efficiency	Principal component, cluster	Various sources
Maltese et al. (2013)	103 Italian province capitals	Smartness	OLS, cluster analysis	Various sources

Source Authors' elaboration

It is followed by a small group of 7 big cities belonging to "good living and moving cities" cluster 4, where mobility and real estate stock are excellent if compared to the average values. If Cluster 4 presents low scores in the environmental variable, in the "ideal cities" (cluster 3) environment proves instead to be taken into account. Two other groups (environmental and energy clusters), which account for 25 % of the cities sample, seem concentrated only on the environmental topic, while the wealth cities, a geographically diffused group, show good results referring to the real estate stock and the health service supply as well. In particular, Energy Cluster (6) will be further described in the next Sect. 2.3.

Finally, it is worth mentioning the studies by Maltese et al. (2013) and Boscacci et al. (2014), which investigate the relationship between smartness and urban performance in the 103 Italian NUTS3 province capitals, where the latter is measured by the residential real estate prices in the semi-central area of the city. Besides, they carried out a Cluster Analysis based on the six Smart dimensions of the Vienna model, in order to find differences and commonalities among the cities. Four different clusters have been identified (see Table 7). The most performing one (Cluster 1) is composed by 4 large "competitive" cities with excellent results in Economy, Governance, Mobility and Living. The second best performing group, is composed by 6 large "attractive" cities mainly located in the North, which present the same characteristics of the first cluster, even to a lower level. Cluster 4, concerning 35 "liveable" cities, instead, includes medium-sized cities all over the country with all the variables over the average, except for unemployment in the Economy dimension. Finally, Cluster 2 focuses on the cities located in the South and in some others peripheral areas. These smaller cities have, on average, the worst scores in all the selected variable, but many of them present results above the cluster average for one of the dimension, suggesting a possible future (smart) specialization, which could help in improving the current situation.

Once more, like in the ranking studies, also in these analyses, Environment doesn't seem to be a driver for the city's smartness. Nevertheless, Energy, which is included in the Environment dimension, plays a key role at urban scale, therefore further investigations are acknowledged.

2.3 The Role of Energy in the Smart City

As concerns the SC, the European Commission promoted some calls about energy efficiency and buildings, renewable energy and supply networks, and green mobility (public and private) for the largest urban areas. Moreover, secondary goals are identified: involving citizens, affecting their behaviour, improving quality of life, and sharing European best practices in sustainable energy management (EU 2012). In particular, the cities have to elaborate and develop action plans for sustainable energy following the European guidelines. The Italian Ministry for the Economic Development states that a SC has to promote Renewable energy and smart grid, Energy Efficiency, and low carbon technologies (MSE 2012). From the

theoretical point of view, and according to the three frameworks presented in the previous Sect. 2.1.1, energy seems to be an important aspect for urban sustainability and smartness.

Actually, in the Nijkamp Hexagon, energy consumption is one of the criteria belonging to the first dimension concerning the natural capital (Ecoware) (Nijkamp et al. 1993). In the IBM report, energy, together with water, represent the infrastructural determinants (IBM 2009), while in the Smart Environment dimension of the Vienna Model the efficient use of electricity (use per GDP) is considered a good indicator for measuring the sustainable management of the resources (Giffinger et al. 2007).

In addition to the three theoretical frameworks, described above, one of the most recent tools for assessing sustainability is the SILENT model (Sustainable Infrastructure, Land-use, Environment and Transport Model): an advanced geographic information system and indicator-based comparative urban sustainability indexing model. This model considers all the major aspects affecting sustainability and highlights the residential resource consumption exploring the energy use levels (Yigitcanlar and Dur 2010).

As described in Sect. 2.2.1, city rankings are another easy tool for identifying the energetic assets of the urban areas, as it has been investigated in recent research reports. Actually, neither ICity Rate (Forum 2012) nor La Dolce Vita (Colombo et al. 2012, 2014) pays close attention to energy indicators, whilst the Ecosistema Urbano provides data on:

- energy consumption *per capita* (annual domestic energy consumption),
- renewable energy supply *per capita* (solar thermal installed and solar electric power on Municipal buildings, district heating volumes)
- energy policies, measured by a composite index (EP) which considers subsidies, rules, open data, the presence of an energy manager and so on (Legambiente 2012, 2013, 2014).

According to the results of the Ecosistema Urbano, only half of the 103 province capitals takes advantage of an energy manager; 73 present solar electric on Public buildings; more than half, instead, have got Solar thermal, while only a third had adopted the heating district measure by 2012. Finally, as concerns the EP index, only Ferrara and Rimini (in the north east of Italy) awarded the maximum score.

In the above mentioned analysis by Siemens-Anci (Sect. 2.2.2), for each considered index, not only the resources stocks, but also the adopted policies have been investigated.

As far as the energy dimension is concerned, they have explored both the energy supply and distribution, focusing on innovative systems (district heating or photovoltaic). Besides, in order to create an index, a principal component analysis has been carried out, starting from the following indicators:

- Solar thermal panels on Municipal buildings (m^2/1,000 inhabitants);
- Solar panels (per 1,000 inhabitants);
- Solar panels power (per 1,000 inhabitants);

- Power of the Solar electric panels on Municipal buildings (kW/1,000 inhabitants);
- Energy domestic consumption (kWh per inhabitant).

The final index is positively correlated to the first three indicators showing a certain propensity for new and renewable energy sources; the fourth one is neutral while the last one, measuring the energy consumption *per capita,* has a negative impact on the index.

According to the general Cluster Analysis conducted on the 54 major Italian cities, six clusters are finally identified, among which, the Energy Cities Cluster presents very good results in the energy index. It is composed by 8 cities in the Centre and the South with a great number of solar panels also on Public buildings. Among these: Foggia, Lecce and Taranto—probably due to the presence of strong Regional regulation—Siracusa, Arezzo, Terni e Latina. As regards the final index, in the North Forlì, Trento e Ravenna seem to pay the closest attention for renewables.

3 Energy, Urban Performance and Smartness: An Empirical Analysis on the Italian Province Capitals

This paragraph is devoted to the analysis, by means of descriptive statistics, of how and to what extent the 103 Italian NUTS3 province capitals differ in terms of "energy" attributes. As presented in Table 5 the considered variables are: (i) solar thermal deployment on public buildings (size); (ii) solar electric deployment on public buildings (power); (iii) presence of Local Energy Plan; (iv) Energy Policy Index by Legambiente. Specifically, the Local Energy Plan collects the main actions for saving energy and for renewables promotion; despite many local differences, it underlines the attention paid by the city to the energy issues, and its

Table 5 Data and sources

Index	Unit of measure	Scale	Year	Source
Solar thermal deployment on Public buildings	m^2/1,000 inhab.	Local	2011	Legambiente
Solar electric deployment on Public buildings	kW/1,000 inhab.	Local	2011	Legambiente
Energy policy (EP) index by Legambiente	Score	Local	2011	Legambiente
Local energy plan	Dummy	Local	2010	Istat
Ecosistema Urbano ranking	Score	Local	2012	Legambiente
ICIty rate	Score	Local	2012	Forum
Checklist (CL)	Score	Local	2012	Authors' elaboration

Source Authors' elaboration

willingness to regulate it. In particular, the Energy Policy Index considers: subsidies, rules, open data, and the presence of an energy manager, etc. (Legambiente 2012, 2013, 2014).

Besides, the following three additional variables, concerning the ranking of the cities, have been considered: (a) the final score of the Ecosistema Urbano-2012 ranking, by Legambiente, focusing on the urban environmental performance in 2012; (b) the final score (ICIty Rate) by the Forum PA, that measures the smartness level of the cities using the six-dimensions' Vienna model by Giffinger et al. (2007); (c) the checklist score (Table 5). The first two variables have been taken into account in order to control for other energy characteristics. The checklist score is calculated starting from the final scores of the three rankings, described in Sect. 2.2.1: La Dolce Vita by Colombo et al. (2012); Ecosistema Urbano by Legambiente; ICity Rate by Forum PA (2012). Following Catalano and Lombardo (1995), every city has been awarded firstly by a score corresponding to the rank in each ranking, and secondly by the sum of these three scores. The best result is represented by the *minimum*. For example, Bologna got the first place in the ICity Rate and the second one in the Ecosistema Urbano, while Colombo et al. (2012, 2014) scored it at firth place. Therefore, following the checklist score, Bologna awarded respectively 1, 2 and 4, whose sum is 7. No other cities did better, so Bologna is the best city according to the checklist method, since it has got the lowest score.

A preliminary analysis at the macro-area level shows that the North-East is best performing in almost all the energy attributes with the exception of solar thermal where the North West performs better (Table 6). Generally, the North West is in the second position for: Ecosistema Urbano, energy policy, local energy plan, while it is superseded by the Centre as concerns the solar electric.

The "energy" attributes are also analysed with reference to the 103 province capitals, and the role played in identifying the urban performance is investigated. To do so, the results of the cluster analysis provided by Maltese et al. (2013) and Boscacci et al. (2014) are taken as starting point. As already stated in Sect. 2.2.2, these studies grouped the province capitals according to the smartness dimensions by Giffinger et al. (2007), but neglecting the "energy" dimension. They identify four clusters (Table 7). Cluster 1, labelled "Competitive Cities" cluster, concerns

Table 6 Variables' average values by macro-area

Variables	Macro area			
	North east	North west	Centre	South and Islands
ICity rate	424.54	388.04	355.12	274.42
Ecosistema Urbano	0.56	0.51	0.48	0.38
Checklist	88.95	139.82	141.12	222.81
Energy policy (EP)	58.86	42.78	32.28	23.36
Local energy plan	0.63	0.43	0.36	0.27
Solar-electric	4.05	1.37	3.58	1.04
Solar-thermal	1.72	2.28	0.84	1.31

Source Authors' elaboration

Table 7 The province capitals belonging to the clusters

Cluster 1	Cluster 2	Cluster 3	Cluster 4
4 competitive cities	58 specializing cities	6 attractive cities	35 liveable cities
Roma, Milano, Firenze, Venezia	Cagliari, Palermo, Mantova, Foggia, Pescara, Potenza, Prato, Pordenone, Trieste, Asti, Campobasso, Pistoia, Cuneo, Novara, Sondrio, Reggio Calabria, Caserta, Grosseto, Terni, Belluno, Alessandria, Biella, Ascoli Piceno, Livorno, Udine, Catania, Latina, Massa Carrara, Matera, Vercelli, Benevento, L'Aquila, Chieti, Rieti, Agrigento, Frosinone, Macerata, Sassari, Siracusa, Taranto, Trapani, Viterbo, Brindisi, Cosenza, Enna, Isernia, Nuoro, Ragusa, Rovigo, Avellino, Catanzaro, Teramo, Lecce, Gorizia, Caltanissetta, Crotone, Oristano, Vibo Valentia	Bologna, Verona, Bolzano, Genova, Torino, Napoli	Rimini, Como, Salerno, Siena, Trento, Brescia, Pesaro e Urbino, Parma, Aosta, Bergamo, Bari, Modena, Padova, Pisa, Piacenza, Reggio Emilia, Treviso, Perugia, Vicenza, Forlì, Lodi, Messina, Ferrara, Ravenna, Imperia, Pavia, Savona, Varese, Ancona, Lecco, Lucca, La Spezia, Arezzo, Cremona, Verbania

Source Maltese et al. (2013)

the best performing cities: Roma, Milano, Venezia and Firenze. These are the largest cities, hosting high added-values activities, a good network of administrations and institutions, and various amenities attracting tourists. On the contrary, despite a good sustainable mobility, pollution in these metropolises is very high; housing market prices are also the highest.

The second best performing group is represented by Cluster 3 ("Attractive cities"), composed by 6 large cities, mainly located in the North, which present the same characteristics of the first cluster, even to a lower extent.

Cluster 4 ("Liveable cities"), instead, includes 35 medium-sized cities all over the country with all the variables above the average, except for unemployment. They do appear good cities to live in.

The tail end is Cluster 2 ("Specializing cities") with the most of the cities located in the South and some other cities in the peripheral areas of the regions they belong to. These smaller cities have, on average, the worst scores in all the selected variables, but many of them show results above the cluster average for one of the dimensions, suggesting a possible future smart specialization, which might help in improving the current situation.

Now, the question is: "are the best performing province capitals even good in saving energy?". To answer to this question a specific analysis of the energy

Table 8 The energy variables and the clusters

Clusters				
	1-Competitive Cities	2-Specializing Cities	3-Attractive Cities	4-Liveable Cities
(8a) Variables				
ICity rate	459.25	309.48	429.33	395.31
Ecosistema Urbano	0.53	0.44	0.53	0.52
Checklist	52.00	198.19	91.50	108.63
Energy policy (EP)	32.00	28.07	62.00	50.44
Energy plan	1.00	0.28	0.50	0.54
Solar electric	0.56	1.08	4.40	4.41
(8b) Dimensions				
Economy	+++	−	++	+
People	−−	+	−	++
Mobility	+++	−	++	+
Environment	−−−	+	−−	−
Governance	+++	−	++	+
Living	+++	−	++	+
Macro area[a]	C	S	NE	−
Size	Metropolis	Small	Large	Medium
Energy	+++	−−−	++	−

Note [a]prevalent macro-area
+/- identify the score being above or below the average score of the Cluster
Source Authors' elaboration

attributes for the four clusters is developed (Table 8a), whose results are compared to those provided by Maltese et al. (2013) and Boscacci et al. (2014), which sintetically identify the clusters according to the six dimensions (Table 8b). It results that all the "Competitive cities" (Cluster 1), with the highest values in the three rankings, have adopted an Energy Plan, while they have not extensively implemented the energy policy, and have not invested in the solar electric, which registers the lowest value. The "Attractive cities" (Cluster 3), instead, show a high value as concerns energy policy, have adopted solar electric, half of them have adopted an energy plan.

The "Liveable cities" (Cluster 4) show the highest value in solar electric, and they are in the second position as concerns: energy policy, and energy plan. Similarly to the results of the previous studies investigating urban performance, the "Specializing cities" (Cluster 2) present the lowest values in the energy characteristics. The energy dimension contributes, therefore, to the success of the cities.

4 Conclusions

Energy plays a key role at urban level: however "smart" may be a city, it surely faces social problems and economic losses if a blackout occurs (Byrd and Matthewman 2014).

Energy is not only dealing with the Environment and Mobility dimensions but also with other Smart dimensions of the Vienna model. First of all, investments in alternative energy can help in creating jobs, thus improving Smart Economy. Smart Governance could also benefit from the smart grid network that could provide: interconnectivity, the development of databases of best practice information for saving energy and time, and the enhancement of e-government and higher levels of collaboration among private and public institutions (regional and local, educational and research institutions, entrepreneurs, and civic organizations). Besides, further benefits are provided by the alternative and renewable sources like the need to reorganize the regional production and the lower dependency from abroad.

As concern Smart Living and People, that is, the quality of life for city-users as well as for citizens, cities have nowadays to cope with new challenges in order to rethink how to manage urban development, and to reduce energy consumption drastically. Lastly, the great opportunity provided by ICT should fill the gap created by the digital divide, eliminating inequalities, and granting a diffused inclusion.

In the present chapter, the importance of energy at urban scale has been investigated, focusing on the major Italian cities. Starting from the analysis of the evolution of the "SC" concept, an extensive review of the theoretical, and empirical studies on urban smartness has been presented. Specifically, the results of the empirical studies have underlined the lack of importance of the environmental dimension in determining the success of the city. Since energy belongs to environment, and represents the focus of the policy agenda, it is worth investigating its role. To this aim, the analysis has focused on how and to what extent the 103 Italian province capitals differ in terms of "energy" attributes. It results that energy matters, nevertheless, it cannot be neglected that not all the several energy characteristics have been considered. Further research might extend this analysis and try to capture the impact of each variable.

References

ABB & The European House-Ambrosetti (2012) Smart cities in Italia: un'opportunità nello spirito del Rinascimento per una nuova qualità della vita. http://www.ambrosetti.eu/it/download/ricerche-e-presentazioni/2012/smart-cities-in-italia. Accessed 10 May 2015

Anthopoulos L, Fitsilis P (2010) Digital cities: towards connected citizens and governance. In: Reddick C (ed) Citizens and e-government. IGI-Global. www.igi-global.com. Accessed 10 May 2015

Barca F (2009) An agenda for a reformed cohesion policy. European Commission. http://www.europarl.europa.eu/meetdocs/2009_2014/documents/regi/dv/barca_report_/barca_report_en.pdf. Accessed 10 May 2015
Barca F, McCann P (2011) Outcome indicators and targets: towards a performance oriented EU Cohesion Policy. European Commission. http://ec.europa.eu/regional_policy/sources/docgener/evaluation/doc/performance/outcome_indicators_en.pdf. Accessed 10 May 2015
Batty M (2012) Smart cities, big data—editorial. Environ Plan B Plan Des 39:191–193
Berry CR, Glaeser EL (2005) The divergence of human capital levels across cities. Pap Reg Sci 84:407–444
Boscacci F, Maltese I, Mariotti I (2014) Smartness and Italian cities. A cluster analysis. TeMA special issue—smart city. Planning for energy, transportation and sustainability of the urban system, June 2014, pp 141–152
Byrd H, Matthewman S (2014) Energy and the city: the technology and sociology of power (failure). J Urban Technol 21(3):85–102
Caragliu A, Del Bo C (2012) Smartness and European urban performance: assessing the local impacts of smart urban attributes. Innovation 25(2):97–113
Caragliu A, Del Bo C, Nijkamp P (2011) Smart cities in Europe. J Urban Technol 18(2):65–82
Carley M, Jenkins P, Small H (2001) Urban development and civil society: the role of communities in sustainable cities. Earthscan, London
Catalano GM, Lombardo S (1995) L' analisi costi-benefici nelle opere pubbliche ed elementi di analisi multicriter. Flaccovio Editore, Palermo
Colombo E, Michelangeli A, Stanca L (2012) Città italiane in cerca di qualità. Università Bocconi, Milano
Colombo E, Michelangeli A, Stanca L (2014) La Dolce Vita: hedonic estimates of quality of life in Italian cities. Reg Stud 48(8):1404–1418
European Commission (2007) Energising Europe: a real market with secure supply. http://ec.europa.eu/energy/electricity/package_2007/index_en.htm. Accessed 10 May 2015
European Commission (2010) A strategy for smart, sustainable and inclusive growth. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF. Accessed 10 May 2015
European Commission (2012) Smart cities and communities. www.ec.europa.eu. Accessed 10 May 2015
European Union (2012) Intelligent energy Europe in action. EU Commission, Brussels. http://ec.europa.eu/energy/intelligent/in-action/index_en.htm. Accessed 10 May 2015
Fistola R (2013) Smart city. Riflessioni sull'Intelligenza Urbana. TEMA 1:47–60
Florida R (2002) The rise of the creative class: and how it's transforming work, leisure, community and everyday life. Basic Books, New York
Florida R (2005) Cities and the creative class. Harper Business, New York
Forum PA (2012) ICity rate. La classifica delle città intelligenti italiane. www.saperi.forumpa.it. Accessed 10 May 2015
Giffinger R, Fertner C, Kramar H, Kalasek R, Pichler-Milanovic N, Meijers E (2007) Smart cities—ranking of European medium-sized cities. Centre of Regional Science, Vienna. http://www.smart-cities.eu/. Accessed 10 May 2015
Glaeser EL, Berry CR (2006) Why are smart places getting smarter? Taubman Center Policy Brief 2006-2. John F. Kennedy School of Government, Cambridge
Hall P (2000) Creative cities and economic development. Urban Studies 37(4):633–649
Hall RE, Bowerman B, Braverman J, Taylor J, Todosow H, Von Wimmersperg U (2000) The vision of a smart city. In: Proceedings of the 2nd international life extension technology workshop, Paris, France, 28 Sept. http://www.osti.gov/bridge/servlets/purl/773961-oyxp82/webviewable/773961.pdf. Accessed 10 May 2015
Hollands RG (2008) Will the real smart city please stand up? CITY 12(3):303–320
IBM (2009) How smart is your city? www.ibm.com. Accessed 10 May 2015
Inoguchi T, Newman E, Paoletto G (1999) Cities and the environment: new approaches for ecosocieties. UN University Press, New York

Jennings P (2010) Managing the risks of smarter planet solutions. IBM J Res Dev 54(4):1–9
Kanter RM, Litow S (2009) Informed and interconnected: a Manifesto for smarter cities. Harvard Business School, Working Paper 09-141
Lazaroiu GC, Roscia M (2012) Definition methodology for the smart cities model. Energy 47:326–332
Legambiente (2012) Ecosistema Urbano. XIX rapporto sulla qualità ambientale dei comuni capoluogo di provincia. www.legambiente.it. Accessed 10 May 2015
Legambiente (2013) Ecosistema Urbano. XX rapporto sulla qualità ambientale dei comuni capoluogo di provincia. www.legambiente.it. Accessed 10 May 2015
Legambiente (2014) Ecosistema Urbano. XXI rapporto sulla qualità ambientale dei comuni capoluogo di provincia. www.legambiente.it. Accessed 10 May 2015
Maltese I, Mariotti I, Boscacci F (2013) Smart cities and housing markets: evidence from Italy. In: Proceedings of XXXIV Conferenza AISRE, Palermo, September, 2nd–3rd, 2013
McCann P, Ortega-Argilés R (2013) Smart specialization, regional growth and applications to European Union Cohesion Policy. Regional Studies—Taylor & Francis
McLuhan M, Nevitt B (1972) Take today. Harcourt Brace Jovanovich, New York
Mitchell WJ (1995) City of bits. Cambridge University Press, Cambridge
Mitchell WJ (2007) Intelligent cities. UOC. UOC Papers no. 5. http://www.uoc.edu/uocpapers/5/dt/eng/mitchell.pdf. Accessed 10 May 2015
MIUR (2012) Smart cities and communities and social innovation. hubmiur.pubblicaistruzione.it. Accessed 10 May 2015
Morvaj B, Lugaric L, Krajcar S (2011) Demonstrating smart buildings and smart grid features in a smart energy city. In: Proceedings of the 2011 3rd international youth conference on energetics (IYCE 2011), Leiria, 7–9 July 2011
MSE (2012) Smart cities and communities, Bando PON National Operational Programme. www.ponrec.it/programma/interventi/smartcities. Accessed 10 May 2015
Nam T, Pardo TA (2011) Conceptualizing smart city with dimensions of technology, people and institutions. In: Proceedings of the 12th annual international conference on Digital Government Research, College Park, 12–15 June 2011
Nijkamp P, Oirschot G, Oosterman A (1993) Regional development and engeneering creativity: an instrumental comparison of science parks in a knowledge society. Free University, Research Memoranda, Amsterdam
O'Grady M, O'Hare G (2012) How smart is your city? Science 335:1581–1582
Ratti C (2012) Decalogue for a (smart) senseable city. In: Keynote speech at Smart City Exhibition 2012, Bologna, Italy, Oct 2012
Ravetz J (2000) Integrated assessment for sustainability appraisal in cities and regions. Environ Impact Assess Rev 20:31–64
Salat S, Novacki C (2010) De l'importance de la morphologie dans l'efficience énergétique des villes. Energie et territoires, Liaison Energie-Francophonie 86:141–146
Sassen S (2011) Who needs to become 'smart' in tomorrow's cities. In: Keynote speech at the LIFT conference, Marseille, France, July 2011
Shapiro JM (2006) Smart cities: quality of life, productivity, and the growth effects of human capital. Rev Econ Stat 88(2):324–335
Siemens—ANCI (2012) EfficienCITIES. Città modello per lo sviluppo del Paese. www.swe.siemens.com. Accessed 10 May 2015
Smart Grid Insights (2014) The role of energy in the smart cities, available at http://etsinsights.com/reports/role-energy-smart-cities. Accessed 10 May 2015
Toffler A (1980) The third wave. Bantam Books, New York, USA
UN-Habitat (1996) An urbanizing world: global report on human settlements. http://mirror.unhabitat.org/pmss/listItemDetails.aspx?publicationID=1650. Accessed 10 May 2015
United Nations (2009) World urbanization prospects: the 2009 version, available at http://esa.un.org/unpd/wup/index.htm. Accessed 10 May 2015
Winters JV (2011) Why are smart cities growing? Who moves and who stays. J Reg Sci 51 (2):253–270

Yamagata Y, Hajime S (2013) Simulating a future smart city: an integrated land use-energy model. Appl Energy 112:1466–1474

Yigitcanlar T, Dur F (2010) Developing a sustainability assessment model: the sustainable infrastructure, land-use, environment and transport model. Sustainability 2:321–340



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