

# Linking future energy systems with heritage requalification in Smart Cities. On-going research and experimentation in the city of Trento (IT)

RESEARCH AND  
EXPERIMENTATION

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**Abstract.** Future Energy Systems in mid-sized Italian Smart Cities are highly dependent upon the pursuit of a smarter grid based on active end-user engagement, the use of distributed energy resources and real-time demand response. In Trento, due to its climatic conditions, the issue of smart energy systems is particularly relevant and its future smart electric grid is expected to produce energy efficiency improvements to the city's historic municipal buildings, as well as to private residences and businesses. With the contribution of Trento's Smart City Municipal Office, latest evidence of current approach to urban smart energy systems is presented, highlighting strategies and innovative solutions, benefitting the whole community within the framework of the broader European goals for sustainability.

**Keywords:** Trento Smart City, Smart Energy Systems, Smart grid, Heritage requalification, Citizen science

## Introduction

Cities are the fastest growing form of settlement worldwide, requiring sustainable energy systems to deal with their increasing density and size. Urban centres are responsible for 67% of the global energy demand and consume 40% of world's energy overall, contributing to climate change being responsible for 70% of global greenhouse gas emissions (UN, 2008). A large part of the urban population live in small or medium-sized cities<sup>1</sup> which play a role in the well-being and livelihood not only of their own inhabitants, but also of the rural populations surrounding them. They are centres for public and private services, as well as for local and regional knowledge production, innovation and infrastructure.

Small and medium-sized cities often play a pivotal role within regional economies. They constitute the building blocks of urban regions and lend character and distinctiveness to their regional landscapes (Knox et al., 2009). It has been argued that their growth and development structure in Western Europe constitutes the most balanced urban system in the world (ESPON, 2006). The generic features of small and medium-sized cities - particularly their human scale, liveability, the conviviality of their neighbourhoods, and their local, cultural and historical characters - in many ways constitute an ideal of sustainable urbanism (Farr, 2008). Small and medium-sized cities are, therefore, essential for restricting rural out-migration, and are indispensable for strengthening territorial cohesion and achieving balanced regional development.

**Trento Smart Energy City** The Smart City as a concept, ambitions, deployed technologies and programmes rapidly gained traction in Trento from the late 2000s onwards and on the basis of the Smart City Index<sup>2</sup> (EY, 2016) the city is currently considered at the forefront of energy efficiency. Trento has been selected in 2014 as an IEEE Core Smart City<sup>3</sup> in consideration to its specific research and experimentation focusing on six significant areas: Big Data/Open Data, Fostering Smart Mobility for

Mid-sized Cities, Innovative Tourism Services, Smart Citizens for Healthy Cities, Energy Systems, and e-Government. Pursuing Big Data and Open Data, Trento is integrating and unifying a formerly fragmented administrative IT structure. The city is also restructuring its internal processes to empower an open data culture and move from an internal to a shared data management approach, even extending across its province. University and research institutions are delivering common initiatives to improve economic operators' and citizens' awareness about key issues (Molinari et al., 2015).

Trento's efforts at Fostering Smart Mobility for Mid-sized Cities aim at providing citizens and visitors with improved, real-time information on public transportation, traffic, multi-modal transportation services and infrastructure that supports both solutions and application development for citizen services (Bedini et al., 2015). In developing Innovative Tourism Services, Trento seeks to optimize the "guest experience" by integrating information and services for an end-to-end tourism ecosystem<sup>4</sup> (Lorenzi et al., 2015). The concept of Smart Citizens for Healthy Cities takes "health" beyond mere physical wellbeing to encompass social, economic and informational opportunities. Trento, as other cities in Europe, faces the challenge of an aging population and a digital divide that can leave the segments of society with unequal opportunities in these areas (Nollo et al., 2015). Effective future Energy Systems in Trento Smart City will depend on the engagement of energy end-users and the pursuit of energy efficiency, distributed energy resources and real-time demand response (Andreottola et al., 2014). E-Government will focus on producing a knowledgeable citizen with access to municipal, citizen-generated data and a 'one-stop shop' way to access it via a simple, trusted, complete, connected and open system (Fioroni et al., 2015).

Given the Alpine climate of Trento, the issue of smart energy systems is particularly relevant, especially as far as the building energy efficiency is concerned. The Municipality of Trento joined the Covenant of Mayors for energy efficiency (EUSEW, 2008) in 2014 by activating procedures to involve the citizenry in the development and implementation of a sustainable energy action plan, which consists of two parts. The Baseline Emission Inventory (BEI) provides information on current and future CO<sub>2</sub> emissions, quantifies the amount of CO<sub>2</sub> to be reduced and identifies the critical issues and opportunities for sustainable energy development of the municipality, along with the potentials of renewable energy resources. The Sustainable Energy Action Plan<sup>5</sup> (SEAP) has identified the actions to be pursued in order to achieve the CO<sub>2</sub> reduction defined in the BEI. Key strategies, as identified by the SEAP



01 | "Le Albere" green neighborhood (RPBW, 2002-2016), 11 hectares urban expansion in a former Michelin factory site in south-west Trento. Image credits: M. B. Andreucci

of Trento, include: the compulsory energy certification of Municipality buildings, especially kindergartens and schools; pilot actions in significant sectors, for the identification of the best operational methods in large buildings with centralized HVAC systems; the construction of new city infrastructures and the retrofit of old ones, e.g., street lighting systems to reduce light pollution and consumption and to improve safety and quality of life; and regulatory actions, such as the definition of building regulations.

### **Linking future energy systems with heritage requalification**

The heritage of public properties of the Province of Trento is complex: 700 buildings (9,539 dwellings) are owned by the social housing company, while 166 buildings constitute the public building stock (Berlanda & Verones, 2017), including a relevant number of institutional structures dedicated to education and sports facilities. An Energy Manager currently handles the energy dissipation of those structures, with 70% of social housing buildings, and 60% of public building stock registering consumption higher than 120 kWh/m<sup>2</sup>y and 45 kWh/m<sup>3</sup>y, respectively (Berlanda & Verones, 2017). Substantial energy savings have been target-



ed - 60% for the social housing and 40% for the public buildings, respectively - with the planning of several building requalification projects (light and deep retrofit) and a preliminarily estimated investment budget of 150 ml euro (Berlanda & Verones, 2017).

Other important actions are progressing under the City Council for Energy Efficiency and Smart Building. A certified information database (the registry of the municipal property) has been created from the aggregation of several existing databases held by different subjects. Various initiatives to train municipal employees and to promote good practices and guidelines for sustainability are also on-going.

Regarding the development of simulation tools, Trento has been involved in two European projects - i-SCOPE and SUNSHINE - and specific models for its territory have been tested with informative results on the basis of the already mentioned relevant real estate and energy consumption data of public buildings managed by the Municipality.

### **From planning to delivery STARDUST- Holistic and integrated urban model for Trento Smart City**

STARDUST is a project funded under the European Union's Horizon 2020 Smart Cities and Communities lighthouse programme. Trento's STARDUST project has been selected by the European Commission among 17 candidates, and funded with a budget of 21 million euros. Together with Pamplona (Spain) and Tampere (Finland), Trento became in October 2017 a lighthouse city designated to develop innovative urban solutions, deploy smart integration measures, test and validate technical solutions and innovative business models. Specifically, the project for Trento involves 3 ITC cross bound action fields: energy transition in the southern urban district with the renovation of 3 of the 14 tower buildings; installation of e-mobility infrastructure (E-VANS and V2G) in the northern logistic district and a car sharing hub (E-Vehicles) in the city center; and citizens' participation related to engaging the population in a structured and constructive dialog by creating a Local Deployment Desk able to involve relevant stakeholders and increase acceptance and consensus.

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02 | The Gold LEED certified Sciences Museum "MuSe" (RPBW, 2002-2013) is located in the post-industrial brownfield of "Le Albere", thus reinforcing the cultural identity of this area of Trento. Image credits: Hufton+Crow



03 | "Palazzo Geremia" (XV) Trento  
Municipality's iconic heritage building,  
restored in 1993. Image credits:  
M. B. Andreucci

The STARDUST project is expected to provide Trento's stakeholders with useful insights supporting the smart integration of "appropriate" technologies with accompanying education and other holistic measures, able to generate desired socio-economic progress through innovative citizens and community engaging platforms, promoting healthy urban relationships and welfare in the highly competitive economy of the Trentino region.

## NOTES

<sup>1</sup> Urban areas in OECD countries are classified as: large metropolitan areas if they have a population of 1.5 million or more; metropolitan areas if their population is between 500,000 and 1.5 million; medium-size urban areas if their population is between 200,000 and 500,000; and, small urban areas if their population is between 50,000 and 200,000 (OECD, 2012; 2016).

<sup>2</sup> EY has been systematically monitoring the ICT diffusion through the Smart City Index, ranking 116 Italian primary municipalities with respect to several thematic areas, from broadband infrastructure to digital services (mobility, education, healthcare, etc.), and 470 indicators of urban sustainable development.

<sup>3</sup> The Institute of Electrical and Electronics Engineers IEEE Core Smart Cities program recognizes and helps cities that are establishing and investing both human and financial capital into smart city plans. Core Smart Cities were chosen through a process assessing criteria including focus, commitment, diversity, roadmap, presence of a strong IEEE Chapter/Section and of a diverse and committed team of partners from the local municipality, to universities, and industries. The selection process also took into account geographic diversity. Acceptance into the initiative required an articulated, pragmatic plan for how the city can become smarter in how it is run, with the goal of improving its citizens' quality of life. Selected cit-

ies receive investment in funding and strategic and practical expert advice to help conduct activities and further the wellbeing of their citizens in a sustainable environment. Current IEEE Core Smart Cities include Casablanca, Morocco; Guadalajara, Mexico; Kansas City, Missouri, USA; Trento, Italy; and Wuxi, China).

<sup>4</sup> Complete system models that can relate drivers of change, such as climate change, to effects on ecosystem structure and functions (Fulton, 2010).

<sup>5</sup> The SEAP relies on a Counsellor for Mobility (political reference), an Environmental Service Manager, an Integrated Solid Waste Project Manager, an Energy Manager, an Enterprise and Citizens Desk Manager, a Planning and Urban Mobility Manager and an Officer for Research and Statistics.

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**Giacomo Fioroni**

Head of Smart Cities Office, Municipality of Trento

Trento fares well in terms of implementing smart city solutions especially in the areas of energy, e-government and mobility. However, prominent among the most difficult challenges faced by the smart city officers is the integration of critical areas of the smart city instead of dealing with them as watertight compartments; the new strategy for Trento Smart City foresees precisely this. This is technically complex and burdensome from an economic point of view: we have to set up the so-called "Smart City operating system", thus laying the foundations for innovative services starting from: an IoT Platform - to systematically collect RT data placed on different physical infrastructures by means of different technological solutions; a Data Platform - to manage, store, analyse and distribute the data gathered from sensors, bringing them together with data owned by the PA and with those collected through crowdsourcing and crowdsensing; interoperability and Integration mechanisms - to guarantee collection of and access to data regardless of the technology used to gather them; dashboard visualization and analytics mechanisms - to visualize data in a format that is understandable and to analyse the different data collected because, in the end, every good decision must be well informed. Trento is a medium-sized city and cannot exploit national PON-Metro fund, specifically thought for metropolitan cities like Milan, Rome and Florence. Consequently, we have to be creative and take advantage of what our area offers, leveraging on: enabling platforms set up by our Province (e.g. open data platform), developing a strong partnership with Bruno Kessler Foundation and the EU projects in which we are official partner. Regarding BKF, in 2015 we signed a memorandum of understanding with the aim of implementing Smart Cities and Communities initiatives. Since then, we have realized many smart projects and we have just started a Smart City Lab focused on one specific neighbourhood ("Vela") in Trento with the aim to implement a first part of the infrastructure mentioned before and to test innovative solutions and services. On the other hand, we are also using the precious funds from EU projects to set up some of the infrastructure needed. Specifically, we are currently involved in four H2020 projects focusing on Social innovation (WeLive), digital services (Simpatico), Big Data for mobility (QROWD) and Smart Cities & Communities (Stardust). The journey is long and is certainly not an easy one, but we are moving in the right direction in accordance with the role conferred on us by IEEE in 2014, being regarded as one of the 10 top smart cities in the world. Certainly, it is our desire to continue to deserve this award.



04 | Trento Open City Platform. It allows for the construction of a federated national platform for service and data sharing among public administrations for the benefit of citizens and businesses. Image credits: Alex Tomasi

## REFERENCES

- Andreottola, G., Asimov, R., Bogomolov, A., Borghetti, A., Brunelli, D., Conti, A., Di Tonno, C., Macii, D., Merkus, P., Nucci, C.A., Panarelli, G., Ragazzi, D., Silvestri, L., Trombino, G. and van Zonneveld, H. (2014), *Energy Systems for Smart Cities*, White Papers from the IEEE Smart Cities Inaugural Workshop, December 2014 in Trento, Italy, available at: <http://smartcities.ieee.org/articles-publications/trento-white-papers.html>
- Bedini, I., Teschioni, A., Lo Cigno, R., Maccari, L., Feroz, F., Gruosso, G., Marconi, A. and Conti, G. (2015), *Fostering Smart Mobility for Middle Sized Cities*, IEEE-TN Smart Cities White Paper, available at: <http://smartcities.ieee.org/articles-publications/trento-white-papers.html>
- Berlanda, F. and Veronesi, S. (2017), *The EU Project FINERPOL and Trentino*, available at: [http://www.energia.provincia.tn.it/binary/pat\\_agenzia\\_energia/ultimora/00\\_berlanda\\_ver\\_nes.1489139119.pdf](http://www.energia.provincia.tn.it/binary/pat_agenzia_energia/ultimora/00_berlanda_ver_nes.1489139119.pdf)
- EY (2016), *Italia Smart. Rapporto sullo Smart City Index 2016*, available at: <http://www.ey.com/it/it/newsroom/news-releases/cs-2016-italia-smart>
- ESPO (2006), *The Role of Small and Medium-Sized Towns (SMESTO)*, final report, Austrian Institute for Regional Studies and Spatial Planning, Vienna; ref. to Sassen, S. (2000), *Cities in a world economy*, (Sociology for a new century), second edition, SAGE Publications, London-New Delhi.
- EUSEW (2008), *Covenant of Mayors on Energy Efficiency*, available at: [http://www.energy-cities.eu/IMG/pdf/concept\\_convenant\\_mayors.pdf](http://www.energy-cities.eu/IMG/pdf/concept_convenant_mayors.pdf)
- Fioroni, G., Pistore, M., Ranise, S., Sciascia, G., Trainotti, M., Amigoni, F., Caporusso, L., Gleria, F. and Maffei, A. (2015), *Smart Government. Toward an Innovative Concept of a "One-Stop Shop" for Interactive Online Services*, IEEE-TN Smart Cities White Paper, available at: <http://smartcities.ieee.org/articles-publications/trento-white-papers.html>
- Fulton, E.A. (2010), "Approaches to end-to-end ecosystem models", *Journal of Marine Systems*, Vol. 81, pp.171-183.
- Lorenzi, M., Mancin, M. and Cagol, S. (2015), *Innovative Tourism Services as a Key Factor for a Successful Smart City*, IEEE-TN Smart Cities White Paper, available at: <http://smartcities.ieee.org/articles-publications/trento-white-papers.html>
- Molinari, A., Maltese, V., Vaccari, L., Almi, A. and Bassi, E. (2015), *Big Data and Open Data for a Smart City*, IEEE-TN Smart Cities White Paper, available at: <http://smartcities.ieee.org/articles-publications/trento-white-papers.html>
- Nollo, G., Raffaetà, R., Caon, M., de Luca, A., Feliziani, C., Andrighettoni, P., Conci, N., Forti, S., Ravanelli, L., Gianordoli, M., Caprino, M., Torri, E., Conforti, D., Mion, L., Conci, M. and Turra, E. (2015), *Smart Citizens for Healthy Cities*, IEEE-TN Smart Cities White Paper, available at: <http://smartcities.ieee.org/articles-publications/trento-white-papers.html>
- OECD (2012), *OECD Environmental Outlook to 2050: The Consequences of Inaction*, OECD Publishing, Paris, available at: <http://dx.doi.org/10.1787/9789264122246-en>
- OECD (2016), *OECD Regions at a Glance 2016*, OECD Publishing, Paris, available at: Knox, P.L. and Mayer, H. (2009), *Small Town Sustainability: Economic, Social, and Environmental Innovation*, Birkhauser Verlag, Basel, CH.
- Farr, D. (2008), *Sustainable Urbanism: Urban Design with Nature*, John Wiley & Sons, Hoboken, New Jersey, USA.
- United Nations (2008), *Expert Group meeting on population distribution, urbanization, internal migration and development*, Population Division, Department of Economic and Social Affairs, UN Secretariat, New York, available at: [http://www.un.org/en/development/desa/population/events/pdf/expert/13/P01\\_UNPopDiv.pdf](http://www.un.org/en/development/desa/population/events/pdf/expert/13/P01_UNPopDiv.pdf)