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CONNECTED CITIES

Smart Infrastructures

How integrated mobility, energy and water services can improve citizens' quality of life

The European House
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The European House – Ambrosetti is a professional Group, operating since 1965, which support companies in the integrated and synergic management of the four critical aspects of value-creating processes: Seeing, Planning, Achieving and Optimising.

For over 50 years The European House – Ambrosetti has been working alongside Italian businesses and each year provides consulting to about 1,000 clients, including more than one hundred strategic scenarios and studies aimed at Italian and European institutions and companies.

For the sixth consecutive year, The European House - Ambrosetti has been nominated - in the category "Best Private Think Tanks" - 1st Think Tank in Italy, among the top 10 in Europe and in the first 100 independent on 6.846 globally in the edition 2018 of the "Global Go To Think Tanks Report" of the University of Pennsylvania.

Hitachi Social Innovation

The Internet of Things (IoT) is creating new opportunities to integrate industrial and social ecosystems by combining the operational infrastructure and sophisticated IT solutions. Major sectors and services, such as transport, safety, energy and health are undergoing transformations that will lead improvements to all stakeholders involved. Such improvements will affect businesses as such as public administrations and will be related to customer and citizens centric developments.

At Hitachi, the activity in the field of digital transformation is defined as "Social Innovation" and is described as the use of technology and new business models to bring about positive changes in people's lives and in society, creating shared value.

The aim of Hitachi's Social Innovation Business is to develop novel solutions through a process of collaborative creation with citizens, municipalities, businesses and other public and private actors, to deploy both IT and OT (Operational Technology) and new business models capable to bring real positive changes to the lives of individuals and societies, creating shared value.

Such positive impact can be particularly effective within urban spaces. Cities' services and related infrastructures are already experiencing transformational changes that will deliver massive customer-centric improvements and vast levels of integration, bringing meaningful benefits for citizens and society as a whole.

To have a broader view on Hitachi's Social Innovation activities and to share our vision of a human-centric digital future, please visit **http://social-innovation.hitachi/eu/**

Contents

01 Introduction

The Connected Cities initiative, launched by Hitachi and The European House - Ambrosetti, is part of the broader framework of **Hitachi Social Innovation** activities and aims to design the most effective strategies to address the major challenges for Italian communities, cities and territories.

The subject of the initiative concerns the digital transformation and integration of services within Italian urban spaces, placing the citizen at the centre of increasingly intelligent and connected cities, with particular attention to the themes of **safety, mobility, energy and water services**.

The study has benefitted from the following **methodological pillars**:

- **Interviews** with high level experts and stakeholders involved in urban development, including: municipalities, civil servants and public administration officers and authorities, main Italian cities' Digital Transformation Officers, private companies including digital providers and integrators, utilities, local public transport agencies, citizens' associations, technological leaders and experts, and start-ups.
- **Qualitative High – Level survey** conducted on a sample of about 150 qualified experts and stakeholders, from business, public administration and academia.
- **Own statistical analysis** based on information collected through major international databases and relevant sources.

The main output are two studies, dealing with the implications, priorities, and future opportunities related to digital technologies' inception and their support for the creation of proper **Connected Cities**. Cities are getting increasingly important as they grow and affirm themselves as one of the main dimensions capable to effectively answer to human future challenges and to address citizens' most relevant needs.

Envisioning the future of cities as **Connected Cities** means to plan and deliver their development putting citizens at the core, through a meaningful use of technology and the participation of all the actors and stakeholders that can play a positive role in such advancements.

As part of the project, this paper deals with the topic of **Smart Infrastructures**, a comprehensive theme including mobility, energy and water services, remarkable issues for the present and, notably, for the future of Italian urban spaces.

Within this context, a key role is played by so-called **public utility services**, namely those activities that provide everyday services to citizens (e.g. water, electricity, natural gas, communications, transportation, ...), carried out by public, public-private, or private players and granted and monitored by the public authorities under the principles of equality, continuity and accessibility.

The way these services will develop in the next decade will play a crucial role in the creation of sustainable Cities, capable to effectively answer to their citizens' and communities' needs. Such development is not granted, as several trends are already posing relevant issues and challenges to nowadays society, while only a **wise and inclusive initial planning** will yield outcomes that measure up to the possibilities opened up by digitisation.

The purpose of this paper is to investigate the major trends and challenges that affect public services' development in Italian urban areas, identifying viable solutions and effective technologies capable to bring to an effective inception of Smart Services in Italian cities, especially with reference to three macro-areas: **urban mobility, energy services and water supply and management**.

The aim of the paper is to **support decision makers** of Italian citizens and to accompany them in their digital transformation, investigating how energy-, water- and mobility-related topics are transforming through time and how innovative technologies are essential to manage them, within the framework of a proper Connected City.

The structure of this paper is conceived accordingly:

- Chapter 2 investigates the main scenario drivers that are reshaping urban spaces with reference to mobility, water and energy services;
- Chapter 3 analyses present and future trends related to urban development, that will influence leaders and decision makers' agenda in the following years;
- Chapter 4 discusses the most pressing issues and challenges for Italian urban spaces, in an age of rapid transition and digital transformation;
- Chapter 5 describes which innovative technological solutions are available and can be exploited to successfully address such issues and challenges;
- Chapter 6 summarise the priorities for all stakeholders involved within the framework of the so-called Connected Cities.

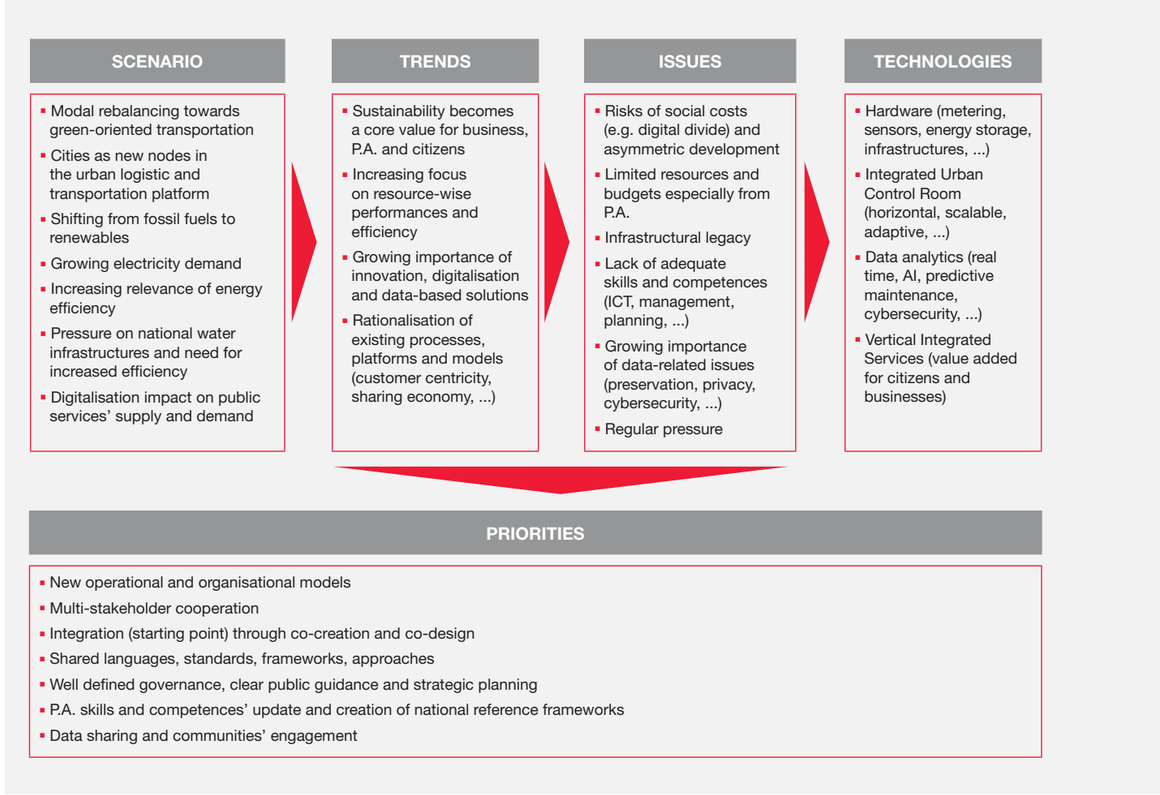


Figure 1. Logical flow of the study. Source: The European House – Ambrosetti, 2019.

Key points of the study

01 Rapid Evolution

In a context of growing technological pressure and rapid evolution of urban spaces, the ability to deliver reliable and valuable services to citizens remains a priority for all stakeholders involved in cities' planning, development and management. The way public utility services (such as mobility, energy supply and water management) are conceived and delivered to citizens will affect the capability of Italian urban spaces to effectively address present and future challenges. In doing so, digital transformation can play an important role, bringing to the creation of proper **Smart Services**, capable to put citizens and their needs at the core.

02 Green Planet

Such evolution must keep into account those major elements characterising current Italian urban scenario and transforming core features of mobility, energy and water supply. While demand for services grows, citizens get increasingly aware of **environmental and social issues**. Businesses and service providers embrace such requests for increased sustainability and efficiency. As a result, transportation mix shifts towards more green-oriented ways of transport, renewables acquire a central role in electricity generation and water grid leakages affirms as a pressing issue to be solved.

03 Rationalisation

In parallel, **cities and urban spaces acquire an increased relevance**. Urbanisation puts growing pressure on cities and on their underlying infrastructures. Citizens ask for more engagement and participation in services-related decisions. Such demand mainly affects municipal-level services. As a consequence, rationalisation of existing processes, platforms and models becomes a priority for city managers and service providers, that research solutions to effectively embrace paradigms such as intermodal transport, customer-centricity, and circular economy.

04 Digital Disruption

Within this context, **digital disruption** occurs. It offers possible answers to such needs, but also contributes to revolutionise both demand and supply of public utility services. Effective and positive inception of digitisation and data-based solutions within public utility services promise to enable proper Smart Services, capable to put citizens and their needs at the core of sustainable and efficient offerings.

05 Digitalisation

At the same time, digitisation brings **challenges and issues** that must be promptly and correctly addressed to maximise the returns of such Smart Services. Firstly, innovation risks to create uneven developments and progresses, leaving part of the country or specific areas and citizens behind. Such risk is increased by current low levels of digital skills and competences in Italy, that also affects the overall creation of Smart Urban Services based on ICT and technologies. Moreover, old infrastructures and urban hardware require vast investments to deploy Smart Services' enabling tools. Such need clashes with decreasing Public Administrations' budgets.

06 Data Collection

Data acquire new centricity in Smart Infrastructures development and provision, becoming a key asset for a Connected City. Data collection, gathering, storage and analysis, together with their transformation into valuable information for service providers and citizens, allow to create integrated services and to turn users into engaged prosumers. At the same time, data-economy related challenges and issues arise, including privacy, data ownership, cybersecurity, creation of required infrastructures (hardware and software) and availability of competences.

07 Smart Services

In addition, **regulation struggles to keep the pace with digital disruption**, often failing to promote the creation of Smart Services or to deploy a conducing environment for innovation, nor it always manages to balance citizens protection and services' provision.

General Data Protection Regulation (GDPR), the latest disposition enacted by European Commission on data management, introduces a strict set of requirements for those who collect, store and manage private data. On one side, it brings an extremely advanced framework for data-economy development, on the other, it requires vast investments and the identification of solutions that allow to stay compliant with its dispositions.

08 Effective and Efficient

Technologies today available promise to solve several of abovementioned issues, also allowing the creation of efficient and effective Connected Cities, capable to deliver innovative Smart mobility, Smart energy and Smart Water services that put new communities' and citizens' needs at the core.

To do so, integration of all actors involved in urban planning, development and management is a key prerequisite. Without full cooperation it will be impossible to create integrated databases capable to mix data from several different sources and to provide valuable information enabling **Smart Integrated Urban Infrastructures**.

09 Horizontal Platform

Such integration can be driven by the creation of a horizontal platform, the so-called **Urban Control Room**, which collects, stores and analyses data gathered from different sources (urban antennas, services providers, citizens…). Under public control, such platform transforms raw data into meaningful information that are delivered to vertical services providers. Big data analytics and Artificial Intelligence software, matched with innovative hardware tools (e.g. smart meters, autonomous driving solution, water grid monitoring sensors, …) are other key technologies that today allow to create Smart Integrated Urban Infrastructures.

10 Public Administration

Efforts must focus on integration. All stakeholders should collaborate to create the horizontal platform and to feed it with meaningful data, enabling smart vertical services. New operational and organisational models are required, together with new competences and skills in all levels of Public Administration. Co-design and co-development of technologies, infrastructures and services are crucial to enable effective integration, and should be pursued since the very beginning, together with clear governance and strategic approach. Finally, citizens and communities must be involved, not marginally, but at the core of such processes.

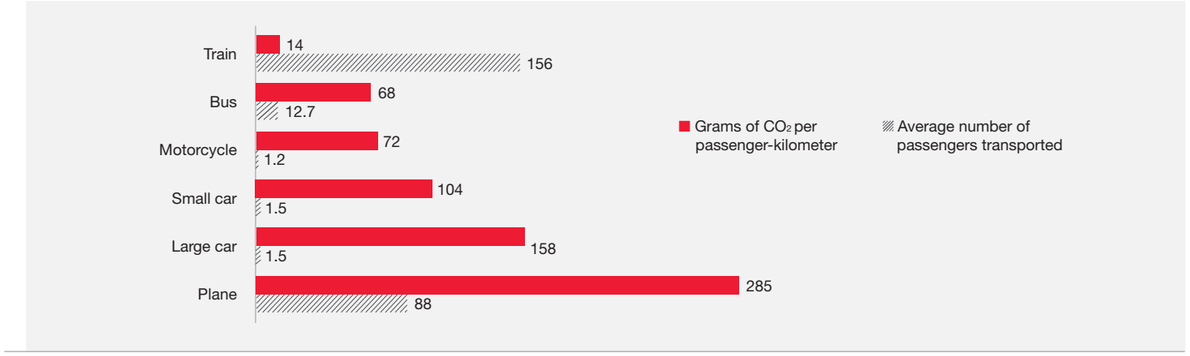
02 Smart transportation and smart services scenario in Italy

This chapter will design the current scenario affecting Smart Transportation (mobility services) and Smart Services (energy and water services), characterised by both common and sector-specific elements. >

Considering mobility, cutting-edge and **green-oriented ways of transport** are emerging and becoming more and more widespread and accessible, impacting on transport activities, infrastructural organisation, regulation and public spaces' management.

- Private cars use is starting a rationalisation process (share of private cars on total travels in Italy was 58.6% in 2017 vs. 65.3% in 2016, carpooling has also increased). [1]
- An overall **modal rebalancing** benefits sustainable transport alternatives. Active mobility and public transportation have grown by 7 p.p. (percentage points) on total Italian citizens' travels from 2008 to 2017 (from 27.5% to 34.5%).
- **Train and metro** (where available) are acquiring growing relevance: their share on total travels [2] has increased by 13.3% and 2.2% respectively between 2012 and 2017.
  - **Train and metro** are still underutilised with respect to EU average: train share on total travels is 6.2% in Italy vs. EU average of 7.7%, and is the lowest value among big-5 EU countries (Spain 6.7%, Germany 8.4%, UK 8.7% and France 9.9%). [3]

Figure 2: CO_2 emissions from passenger transport: grams of CO_2 per passenger-kilometer and average number of passengers transported (grams and absolute value), 2016. Source: The European House – Ambrosetti elaboration on EEA data, 2019.



1 Percentage of car journeys as a passenger has risen from 8.5% of 2016 to 12.3% of 2017. Source: The European House – Ambrosetti elaboration on Isfort data, 2019.
2 Intended as million passengers per km travelled.
3 Source: The European House – Ambrosetti elaboration on Isfort, Conto Nazionale delle Infrastrutture e dei Trasporti and Eurostat data, 2019.

Regulation has played a key role in such modal rebalancing as mobility sector represents a central element in national and EU climate change policies: one of the major priorities at all levels of Public Administration remains the **reduction of environment impact** coming from transportation, as:

- The sector is responsible for more than 30% of CO_2 emissions in EU and 34% in Italy.
- It is the only economic sector that has **increased the emission levels** since 1990, both in EU (+28.2% from 1990 to 2017, while overall emissions in EU decreased by 24.4%) and in Italy (+2.3% over the period, with a decline of total emissions by 20.4%).
- In 2017, 39 Italian provinces have exceeded the permitted annual limit of 35 days for **PM_{10} particles in the air** for which one of the main causes is the smog generated by car exhausts (share of 12.2%, second largest contributor after industrial combustion activities).[4]

For all these reasons, the **regulatory framework** is focusing on measures encompassing both EU, national and local level:

- In October 2018, the **European Parliament** has voted to further reduce vehicles pollutants emissions by 20% from 2025 and by 40% from 2030, other than asking 35% of new cars registered from 2030 to be electric or hybrid.
- In Italy, the **Roadmap for Sustainable Mobility** jointly launched by the Ministries of Transport, Environment and Economic Development in 2017 attempts to address transport-related pollution in an integrated way.
- At local level, a multiplicity of **large cities** is imposing access bans in central areas [5] and restrictions to cars with poor emission standards. In Milan, for example, from February 2019 the access to 72% of the city surface – that covers 97% of the resident population – will be prohibited to Euro 0-1-2-3 diesel vehicles thanks to the so-called "Area B" (low emissions zone) Regulation, adding to the already enforced "Area C".

Proposals of this nature are expected to **significantly impact mobility habits in urban areas**, as 38.3% of the current Italian car vehicle fleet still has emission standards equal or lower to Euro 3. [6] Survey's results confirm that the course is plotted. Public Administrations have indicated the implementation of limitation measures for individual transport as third priority (22%) in order to lower road traffic and congestion in their area, after enhancing investments in public transport systems (28%) and in sharing mobility solutions (25%).

In parallel, cities are increasingly acquiring the **role of nodes in the urban logistics and transportation platform**, facing unprecedented pressure, but also having the chance and the responsibility to become the driving force for the change in the national and regional transport paradigm.

- **Daily demand for mobility** in Italy has rapidly grown in the last years[7], at the same time accompanied by the propensity to travel shorter distances.
- Demand for mobility is getting increasingly **centred around large urban areas**, both within and between cities and other relevant areas (such as major non-urban production hubs, logistics nodes, ...).

4 Source: The European House – Ambrosetti elaboration on EEA, Legambiente and Ispra data, 2019.
5 The so-called ZTL.
6 Source: The European House – Ambrosetti elaboration on ACI data, 2019.
7 National daily mobility rate in 2017 was 88.5%, 5 p.p. higher vs. 2012.

To address such issue, the **"intermodal paradigm"** - defined as the combination of different modes of transport in a seamless passenger travel experience or freight transportation - is acquiring relevance within urban development strategies, transport investments and infrastructures' planning as a key tool to achieve a better, smarter and more rational organisation of transport.

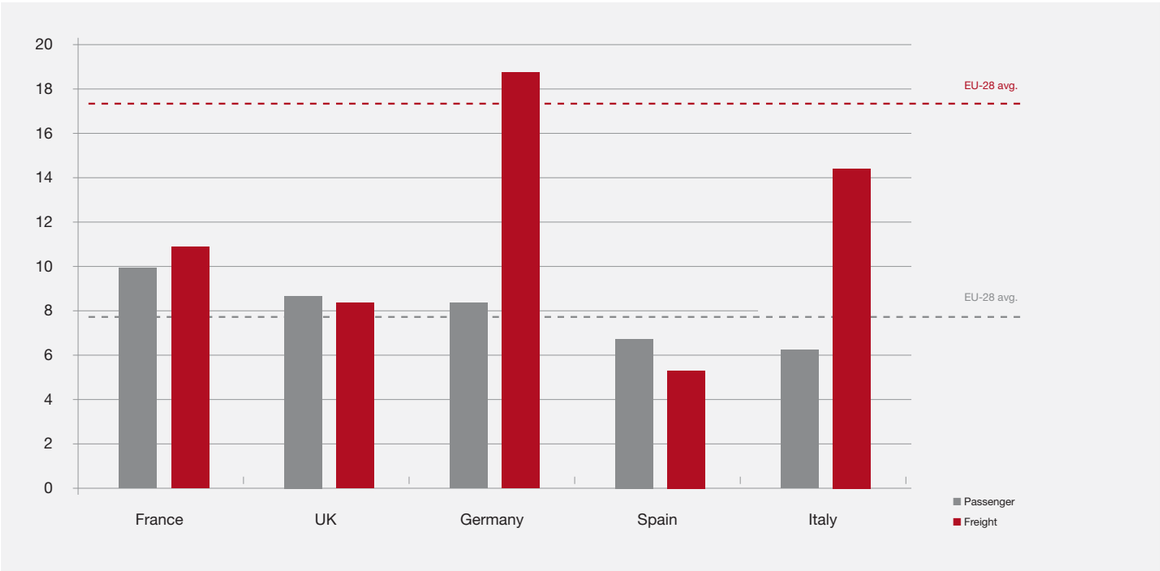
- The share of intermodal transportation on total travels significantly raised in Italy **from 3.8% in 2008 to 4.6% in 2016** (in 2001 it was 2.3%).
- However, **2017 marked the first year of decline**: the share of intermodal travels on total travels diminished by 0.7 percentage points, representing a critical point of attention for our country.
- **Public transportation is fundamental** for the expansion of intermodality. In 2017 combinations among private means accounted for just 1.9% of total intermodal solutions, combinations among public transport accounted for 21.1%, while combinations among private and public means represented the preferred choice, with a share of 71.1%. [8]

The development of **rail transportation is the cornerstone** of the implementation of the intermodal paradigm, as it is the most efficient way to connect nodes (mainly from extra-urban to urban areas), both for passengers and freight transport. However, in Italy rail transport share on total travels remains low.

In parallel to intermodality, **electrification** in both individual and collective transport is today affirming as a priority. When addressing **individual mobility**, electrification remains a long-term issue.

- The higher **electrification potential** in our country is estimated to be in the transport sector (among all economic sectors), both public and private, also because the starting point is much lower with respect to the building and industry branches. Electrification rate [9] in transport is projected to grow from the current 2% (in the building sector is 26% and in the industry 35%) to a range comprised between 5-8% in 2030.
- Major urban centres will be leading this transition, which is expected to be massive: according to three alternative scenarios for electric penetration at 2030 in Italy, overall Italian turnover and value chain will boost in the near future, reaching an estimated value comprised between **€102.5** and **€456.5** million in 2030. [10]
- Surveys' results confirm such importance: 77% of respondents consider that in the short to medium term the transition towards electrification of public and private vehicles will be a **priority for urban mobility**.
- Considering individual transportation, electrification in Italy still shows a **significant gap with the rest of EU: in 2017**, sales of electric cars (BEV and PHEV [11]) are 0.24% on total sales (representing 0.04% of the existing stock, despite a CAGR of +48% in sales between 2012 and 2017). Italian electric circulating park represents less than 2% of total electric fleet in Europe (EU electric car sales CAGR is also higher: +69% from 2012 to 2017).

Figure 3: Rail transport share on passenger and freight modal split in big-5 EU countries and EU average (percentage values), 2016. Source: The European House – Ambrosetti elaboration on Eurostat data, 2019.



Considering **public transport**, instead, electrification technologies are already developed and capable to deliver substantial benefits to cities and citizens, especially looking at rail transport.

- Electrification of **railway lines** is the principal contributor of the actual 2% electrification share in the overall Italian transport sector. In 2016, electrified railway lines represented 71.2% on the total railways, which positions itself in 5th position in the EU (where average electrification rate is 49.7%).
- **Bus transport** remains an area of major concern: 2017 stock of electric urban buses (a total of 455 vehicles) represent only 1% of the total fleet, lower than the EU average of 1.6%, with UK, Germany and Netherlands being the major market leaders. Electrification of bus fleet in our country would be even more impactful considering their obsolescence: on average, 6 buses out of 10 in Italian cities have more than 10 years (compared to 3 out of 10 of France). [12]

The electrification of public and private transport goes hand in hand with another trend: the development of **autonomous driving** solutions. Once again, automation in private transport is far from being deployed at systemic level and in everyday use, while several implementations of autonomous driving in public transport are already affirmed. It is the case of Driverless Metro of Milan and Brescia, that confirm how electric and autonomous public transport can deliver increased efficiency, contributing to achieve socio-economic and environmental objectives in Italian cities, by contemporarily bringing practical solutions that improve passenger experience and citizens' everyday life.

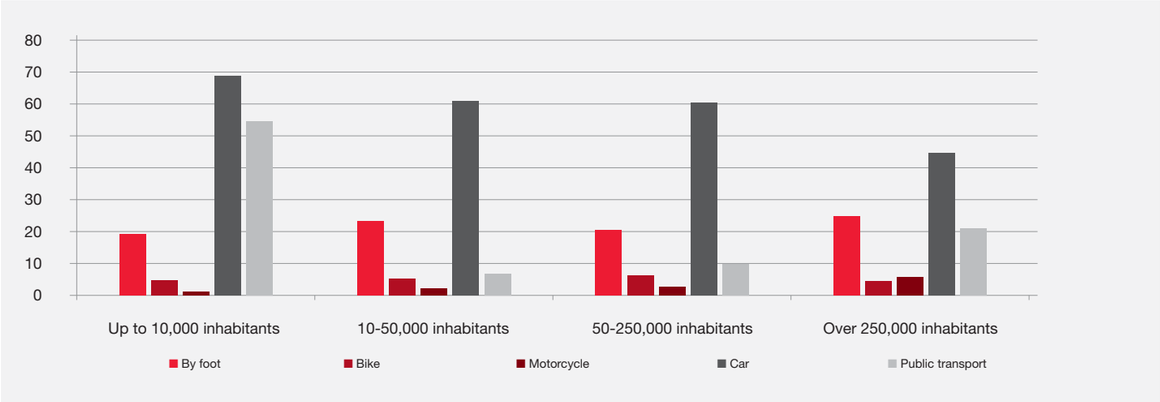
A further element to consider is the progressive dichotomy between **urban and suburban areas**, that need to be filled in order to provide real intermodal and customer-centric services capable to deliver systemic benefits:

- Modal split is well-differentiated between **urban and extra-urban areas** in Italy. Within municipal perimeter, the non-motorised travel component (active mobility by foot or bike) reaches a share of 38.6% on total travels in 2017 (+9 percentage points vs. 2008). Public transport is also raising its relevance, achieving a quota of 9.3% (+0.9 percentage points vs. 2008), at the detriment of private means, whose share was 52.1% in 2017, decreased by -6.7 percentage points from 2008. The profile changes in extra-urban areas, where private cars still account for 84.8% of total travels, public transport for 12.3% and active mobility for 2.9%.
- In urban areas, **public transport** is more exploited than 10 years ago (+2.6 percentage points). In suburban areas this share remained unaltered, a sign that service improvements have been mostly carried out and focused on large cities.
- Large differences also exist between **urban areas of different dimensions**. In fact, those who live in smaller municipalities (up to 10,000 inhabitants) tend to use much more cars (almost 70% on total travels in 2017) and less sustainable means of transport, especially public transport (whose share is on average lower than 5% of total modal split).
- To deliver systemic benefits, the North – South gap has to be addressed too: in 2017, public transport had higher modal shares in North-Western (12.8%) and Central Italian regions (12.4%), where the weight of large metropolitan areas is very high, while the lower value is observed in the South (8.1%). [13]

8 Source: The European House – Ambrosetti elaboration on Isfort data, 2019.
9 The electrification rate is the share of electrified infrastructure (e.g. railways) and products (e.g. car) of a sector.

10 Source: The European House – Ambrosetti elaboration on Electrify 2030 research by The European House - Ambrosetti, 2019.
11 Battery Electric Vehicles and Plug-in Hybrid Electric Vehicles.
12 Source: The European House – Ambrosetti elaboration on Conto Nazionale delle Infrastrutture e Dei Trasporti, European Commission and C40 data, 2019.
13 Source: The European House – Ambrosetti elaboration on Isfort data, 2019.

Figure 4: Modal distribution in Italy according to the municipality size (percentage value), 2017. Source: The European House – Ambrosetti elaboration on Isfort data, 2019.

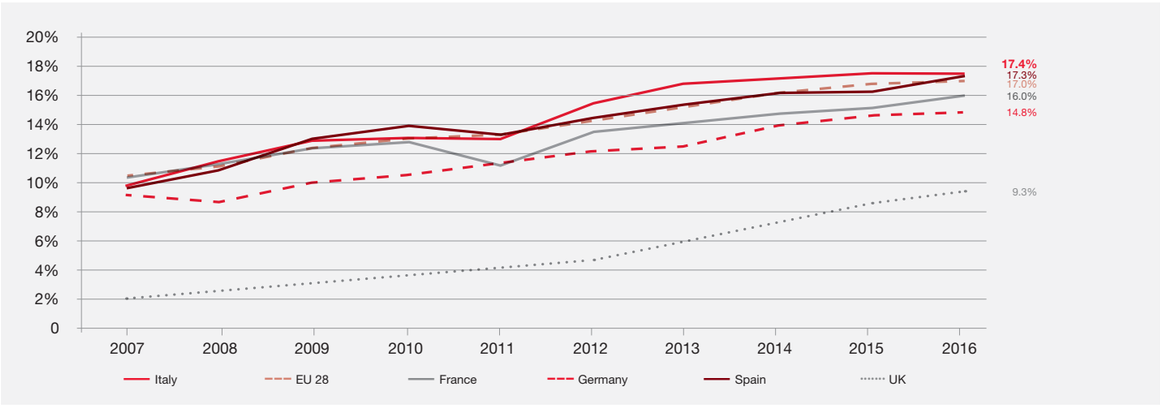


As for mobility, Italian scenario in the **energy and water management and supply sector** is evolving, affected by consumers' needs, regulation input, and innovations.

The energy sector has experienced a shift from fossil fuels in favour of **renewable sources** both in energy consumption and production over the past years. Environmental concerns have grown and the necessity to decarbonise economic activities has been driven by EU regulations.

- In Italy, the share of renewable sources on overall energy consumption has increased by more than 10 p.p. since 2005, reaching a level of 19% in 2017; in this specific field, the country has already **surpassed the 2020 EU fixed target** of 17%. However, maintaining current pace, the objective for 2030 (28%) seems rather difficult to be achieved. [14]
- Therefore, the actual **Italian energy mix** has seen a noteworthy increase of renewable sources (CAGR of +9.1% in the period 2007-2016), to the detriment of natural gas (CAGR of -3.4%) – which still remains the largest source utilised in the Italian energy mix, accounting for 38.8% on total energy consumption – and of the most polluting energy sources, oil and coal (CAGR of -3.4%). [15]

Figure 5: Share of renewable sources on overall energy consumption in Italy, principal EU countries and EU average (percentage on total), 2007-2016. Source: The European House – Ambrosetti elaboration on Eurostat and GSE data, 2019.



Rapid and effective integration of renewable sources within the Italian energy system continues to be a priority also considering that **national electricity demand is resetting on a growing trend**:

- After a drop in the aftermath of the 2008 crisis, in the period 2014 – 2017 energy demand has risen with a CAGR of 1.1% (vs. EU average of 0.4%). Future scenarios expect a growth in electricity demand in the 2017 - 2026 period comprised between 0.4% and 0.9%. [16]

Growth of renewable sources has reduced the **flexibility of the electrical system**. Non-programmable sources – precisely because of their unpredictability and inconstancy – without adequate countermeasures can cause congestion in the electricity grid, with the risk of obtaining power spikes or blackouts.

For this reason, the **streamline of the electricity grid** is pivotal to sustain new installations and to increase intra- and inter-regional transport capacity, predicting, avoiding, managing and resolving possible congestions. Within this context Italy:

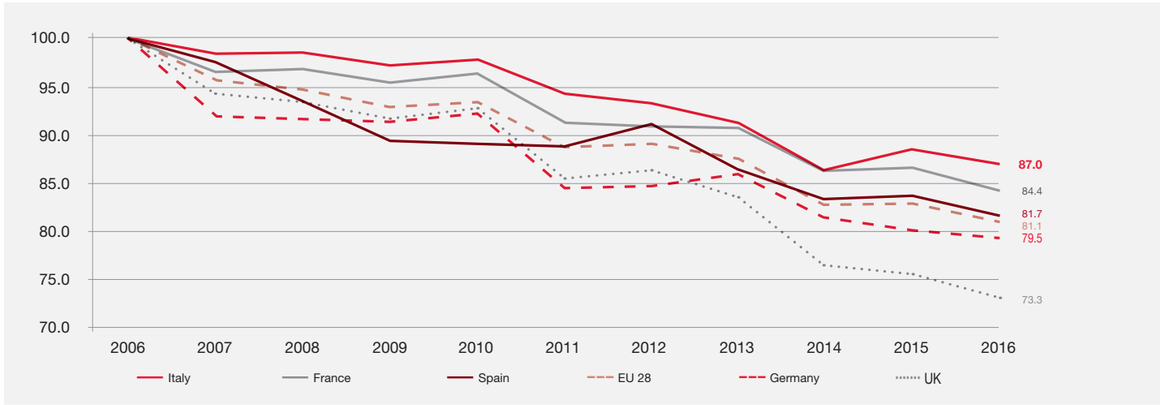
- Has reached almost 9% interconnection capacity [17], in the light of the EU target of 15% set for 2030, possessing **one of the most robust electricity grids of the continent**.
- Has planned to invest €600 million in the period 2018-2023 in **digitisation and grid innovation**, two key enabling factors that will accompany the growth of renewables and allow grid streamline. [18]

Necessity of grid update and streamline is equally remarked by the outcomes of our surveys: qualified stakeholders of the energy and utilities sector almost unanimously agree that a complete integration of renewables in the national energy system is the key path to decarbonise economic activities with a fast pace. Investments in renewables growth is in fact the first perceived priority for next future energy sector in Italy (76% of the respondents included this option as one of the top-three priorities), before investments in urban requalification solutions (71%) and the development of new skills to tackle new market requirements (57%).

An additional trend refers to the increased relevance of **efficiency**. Energy efficiency practices in our country are bringing to an overall improvement of the national energy system, even though not always in line with EU targets and on par with other EU countries:

- In 2016, **primary energy intensity values** in Italy were lower than EU average (-16.9%) and the principal EU countries (-10.9% with respect to Spain, -11.3% to Germany and -15.9% to France). Despite this, our country displayed the worst performance in decreasing energy intensity in the last 10 years, -13% from 2006 to 2016 (vs. EU average of -18.9%).

Figure 6: Primary energy intensity in Italy, in principal EU countries and EU average (index year 2006 = 100), 2006-2016. Source: The European House – Ambrosetti elaboration on Enea and EEA data, 2019.



14 Source: The European House – Ambrosetti elaboration on Enea and GSE data, 2019.
15 Source: The European House – Ambrosetti elaboration on Terna data, 2019.

16 Source: The European House – Ambrosetti elaboration on Terna and Eurostat data, 2019.
17 The grade of connection among electricity systems through proper infrastructure, needed to improve electricity security of supply.
18 Source: The European House – Ambrosetti elaboration on Arera and Terna data, 2019.

- National **investments** in energy efficiency solutions are growing: 2017 has been a record year in Italy, €6.7 billion, with a +10% increase vs. 2016 (€6.1 billion) and +76% increase vs. 2012 (€3.8 billion).
- The **role of Italian cities is crucial**, as they produce the largest share of pollutants emissions in the country (11 Metropolitan Cities out of 14 have exceeded the annual limit for NO_2 emissions in 2017).
- The **Home & Building segment** is particularly relevant in this field, given that the majority of Italian buildings do not have acceptable energy classes: just 2% of Italian house stock is catalogued under Energy Class A (the best), while 56% is under Class G (the worst). The sector leads the ranking of investments in energy efficiency: 65% of the total (+10% between 2012-2017), followed by industrial sector (33%, +12% over the period), and Public Administration (2% of total investments).
- Looking at the products on which investments have focused, **efficient heat pumps, illumination technologies and cogeneration systems** are the three main solutions sold in the market in 2017. [19]

Regulatory planning and decisions at both EU and national level also stress energy efficiency improvements. In Italy, in 2017, the Ministry of Economic Development has presented the new National Energy Strategy (SEN), which sets clear targets to improve sustainability, security of supply and competitiveness of the national energy system. The regulation is in accordance with the mandatory reference EU directives: the 2020-2030-2050 Climate and Energy Package.

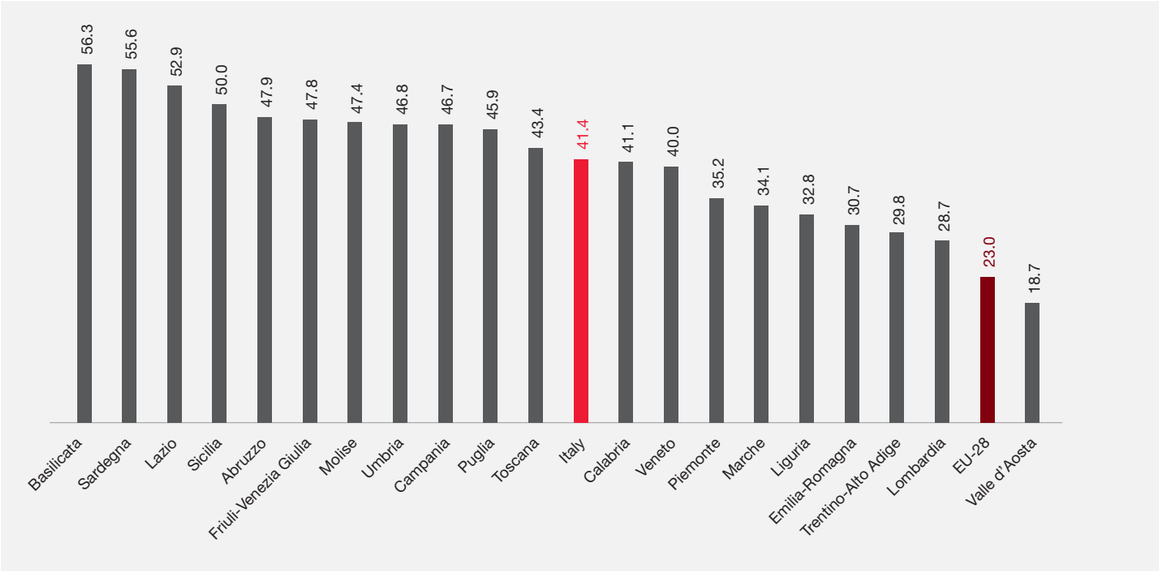
Efficiency is also a key topic in w**ater management and supply** services. In this field, current Italian performance is poor, making the issue of proper and efficient management of increasingly scarce water resources more and more compelling:

- In Italy, total water volume withdrawals are estimated to be about 33.7 billion cubic meters in 2016. In per-capita terms, Italy has the **worst level of annual potable water withdrawal in the EU**, 156 cubic meters per-inhabitant. [20]

- The civil water grid requires considerable investments, given the fact that a significant amount of energy is required to bring water to final users and that the **level of national water grid leakages is extremely high**: at the end of 2015, in Italy, the water delivered to the distribution networks touched an average dispersion [21] of 41.4% (vs. 32.1% in 2008). Current water leakages (around 3.4 billion cubic meters), costs to Italy €750 million/year. [22]
- Breakdowns on Italian water grid are about twice greater than in EU and one of the main causes is undoubtedly the **lower maintenance rate**: only 0.38% of the Italian water supply is maintained every year, compared to 0.57% of the EU one.
- Furthermore, coverage and sewerage levels of Italian service are lower than EU levels. This is mainly due to the lack of a capillary water infrastructure necessary to serve the Italian territory and its inhabitants.
- Concerning grid losses, the situation is very heterogeneous between regions, peaking to more than 50% in Central and Southern Italy (in Lazio, Basilicata, Sicily and Sardinia).
- More concerningly, investments in Italian water grid management are decreasing: in 2012, local authorities spent about €700 million and operators €1.2 billion, while in 2016 the former only €511 million and the latter €1.1 billion. [23]

The surveys confirm that the main concern of key stakeholders in the utility sector is to develop novel solutions to tackle the problem of water leakages in the national grid (44%).

Figure 7: Water dispersion in Italian Regions (percentage on total water supply), 2015. Source: The European House – Ambrosetti elaboration on Istat and EurEau data, 2019.



19 Considered products capable to improve performances in buildings, production plants and urban energy systems at the same time.
Source: The European House – Ambrosetti elaboration on Istat, Ispra, EEA, Energy Strategy Group and Enea data, 2019.

20 Agriculture is the sector withdrawing the largest water volumes, about 50.5%, although it marginally exploits the water grid and has the lowest energy consumption. The industrial sector withdraws 22.9% of the total and is mainly based on dedicated withdrawal systems. Finally, in the civil sector, which is supplied almost exclusively from the water grid, withdrawals amount to 26.7% of the total.

21 Difference between released water to the grid and delivered water to the user.

22 Assuming that 90% are real losses with a marginal production cost of 0.1 €cubic meter and 10% are commercial losses with an average tariff of 1.3 €/cubic meter. Costs and tariffs refer to Italian values.

23 Source: The European House – Ambrosetti elaboration on Istat, Water Management Report, GWI and Utilitatis data, 2019.

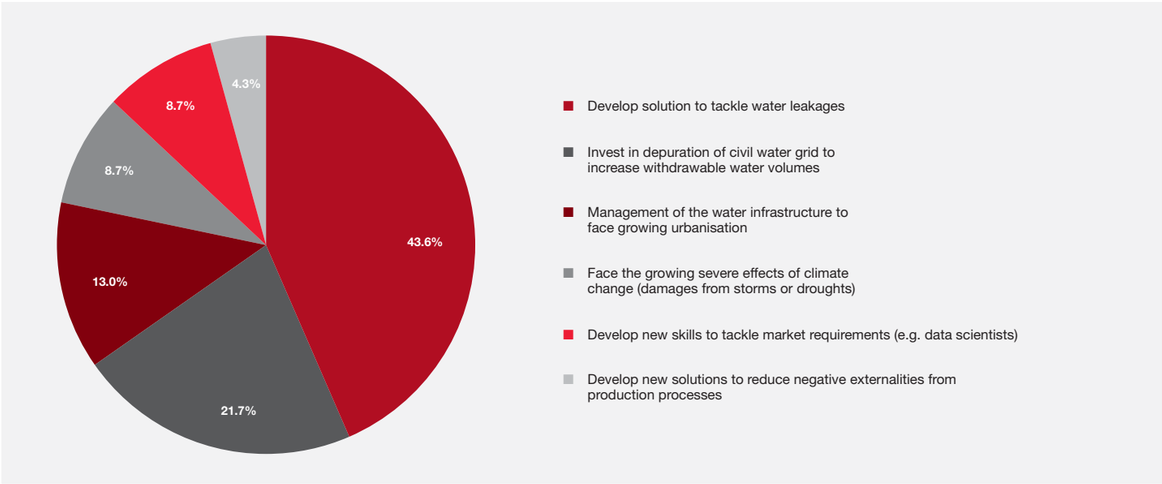
A further trend refers to **digitalisation and IoT**, which implicate services' integration mainly through the exploitation of data.

- Both **energy and water sectors** are experiencing a marked digital transformation, including potential value-added services enabled by smart meters, smart grids and monitoring sensors for water grids. The market is receptive: Italy has already surpassed the required share of installed smart meters in the electric grid: 99% (vs. EU objectives of 80% by 2020). An important role has been played by industry leaders, energy suppliers and service providers, that benefitted from clear, long term, supporting regulation.
- The same is true for **mobility**. In 2018, Italian citizens spent €246 million in digital solutions to move in urban areas (+30% over the last quarter). The largest share is accounted by public transport, with an expenditure of €114 million (46.5% of the total). Rail transport is also digitalising, with Ferrovie dello Stato Italiane, main national rail transport player, expected to invest €7 billion in ICT between 2017-2026. Furthermore, €100 million will also be invested for ICT in integrated logistics while other important fields will be related to signalling and to create a proper digital travel experience. [24]

In conclusion, the current scenario of the Italian mobility, energy and water sector is today reflecting the development of three main coexisting drivers:

- Consumer habits and related requirements are changing fast, delineating a new kind of demand focused on sustainability, simplicity, transparency and participation (**Customer-Centricity**).
- Industrial players, technology leaders and service providers are investing in R&D, technologies and innovations to deploy **Smart Infrastructures** capable to match new citizens' needs and maximise positive returns for both customers and stakeholders.
- Regulators and Public Administrators struggle to not fall behind technological developments, trying to anticipate and steer them despite budget constraints and the coexistence of national, European and international **regulatory frameworks**.

Figure 8: What are the priorities and needs that you identify in the near future for the national water system? (percentage share on total answers), 2019. Source: The European House – Ambrosetti elaboration on surveys' results, 2019.



24 Source: The European House – Ambrosetti elaboration on Enel and Ferrovie dello Stato data, 2019.

03 Emerging trends

The evolution of modern society driven by technological advancements paves the way to the development of "**Connected Cities**", intelligent urban spaces that through new digital technologies and organisational and operational models are capable to offer value added services to their citizens, answering their needs and satisfying their expectations.

In this context, the new paradigm of "**Smart Infrastructure**" provides for an innovative, efficient and sustainable model in the supply of mobility, energy and water services. They are based on smart, digital and technological solutions (hardware), together with associated functional planning and operative structures; their aim is to put citizens at the core of the discussion, avoiding phenomena linked to the urban sprawl, as the risk of increased inequality and exclusion, as well as deterioration of quality of life levels in urban and suburban areas.

To take the most out of these solutions, it is crucial to understand those **major trends** that comes from the abovementioned scenario, that is leading to remarkable changes in the way public utility services are delivered, driven by different economic operators and both endogenous and exogenous factors. These trends are affecting not only public services, but also the way urban spaces are managed and developed.

The present chapter will hence outline the main ongoing trends, providing useful knowledge base to understand, anticipate and sustain future Smart Infrastructure development in Italy.

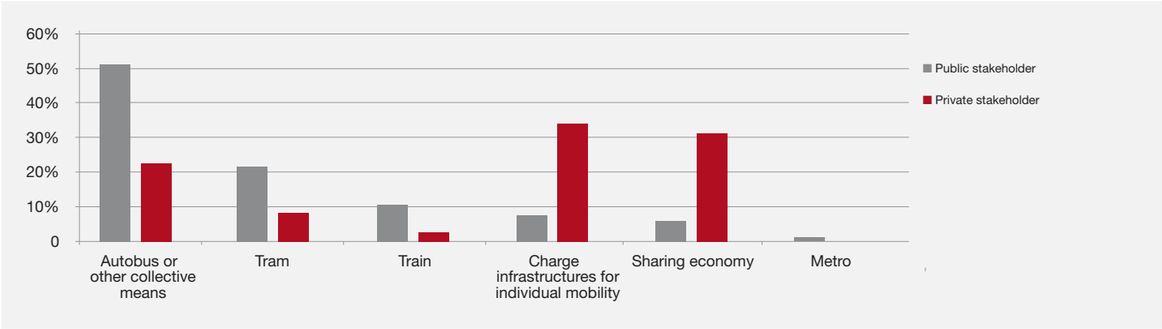
First of all, a clear trend that emerges from technological progresses, companies' priorities, customer awareness and stakeholders' interests is related to **sustainability**, not only steered by regulation and increasingly perceived as valuable by itself.

In the mobility sector, the main priority remains to lower pollutants emissions. Besides disincentivising the private car usage through the enhancement of local public transport strategies and ban measures, **gradual electrification of vehicle fleets** (public and private) together with underlying infrastructures is assuming great emphasis in policy-makers' and firms' agendas.

- The survey outlined that the major action of municipalities, especially looking at large urban centres and metropolitan cities, will focus on the **electrification of collective transport**, such as trains, tram and buses. On the citizens side, instead, there is greater demand for tools to promote and facilitate the adoption of electric or hybrid cars/motorcycles. [25]
- This demonstrates and confirms that a **collaborative approach** is needed to satisfy different exigencies and requirements, in order to avoid the deployment of unnecessary or non-prioritised solutions.

25 Percentage of car journeys as a passenger has risen from 8.5% of 2016 to 12.3% of 2017. Source: The European House – Ambrosetti elaboration on Isfort data, 2019.

Figure 9: In which area will do you think it is necessary to focus actions towards greater electrification? (percentage on total), 2019. Source: The European House – Ambrosetti elaboration on surveys' results, 2019.



- From an industrial standpoint, elements of **competitiveness** are significant, as Italy has a long tradition in the automotive industry: hence, the opportunity of e-Mobility must be exploited to innovate and remain a manufacturer leader in the sector.
- As examined in the previous chapter, electrification for private and public transport in Italy is growing with slower pace with respect to the rest of EU countries. Survey results point out that the most important obstacles to electrification inception are: lack of **adequate public support**, low investments by some sectorial major players, high vehicle costs, infrastructural legacy, lack of sufficiently mature and competitive technologies (e.g. battery technologies).

In the energy and water sector, the achievement of a more sustainable system regards the constant increase of **renewable sources adoption**. The development of renewable sources is not only functional to emissions reduction, but also to the containment of energy dependence and, in the future, to the reduction of the existent electricity price gap if compared to the European average. [26]

- According to the National Energy Strategy, in line with EU Climate and Energy Directives, coal and oil are almost expected to disappear from 2025 Italian electricity generation mix, replaced by an increased use of natural gas and especially **RES (renewable energy sources), expected to raise their contribution by 70% compared to 2015.**
- Among the various renewable sources there is, however, a great difference in terms of expected development: **wind and photovoltaic** are expected to grow significantly (x2.5 the first, x3 the second compared to actual data), hydroelectric and geothermal are foreseen to be almost constant, while for biomass forecasts point out a declining trend.
- In terms of investments – considering a consistent alignment with the SEN objectives and assuming a further, but limited, reduction in installation costs – the expected value needed for a complete deployment to 2030 targets is about **€4.5 billion per year**, compared to total €1.6 billion invested in 2017 in this field.
- Moreover, looking at these forecasts, it is noteworthy to highlight that generation from **"utility scale" plants** will have to be predominant compared to the others, with residential plants having the higher expected growth (about 850 MW per-year). This implicates that once again major urban areas initiatives and planning will guide a virtuous development towards Smart Infrastructure models.
- Electrification also requires advanced **storage technologies**, crucial to enable innovative solutions, such as accumulation in the form of service. [27] As a confirmation of their relevance, investments in storage technologies are the fourth priority for the future of the energy sector according to the outcomes of our survey (52% of respondents has indicated it within the top-three priorities), after other significant necessities as integration and growth of RES, development of new skills and investments in urban requalification. [28]

Other than sustainability, a second trend is related to **efficiency**, as both companies and users increasingly require a focus on **resource-wise performances**.

- Efficiency is pursued in mobility (vehicles with lower energy and fuel consumption), in infrastructures and buildings (improved materials and performances), and in production and organisational processes (better management, planning, …).
- In the energy sector, savings and efficient performances must be primarily considered as a rationalisation of production processes, since energy-related expenditures play a key role in firms' budgets. In this sense, there is a plurality of solutions that **service providers and technological players** are developing in order to improve energy efficiency performances.
  - Among the others, most promising areas of innovation include: district heating, cogeneration systems, integrated solutions for **management and monitoring (e.g. smart grids)**, circular economy approaches - waste-to-energy plants allows to generate new energy without exploiting new resources – for processes and for the energy system in general, and domestic solutions linked to domotics (e.g. smart meters, efficient heat pumps).
- Considering water services, efficiency is more urgent than ever: in Italy no improvements have been made in the last years, as the share of population living in areas with hydrological problems is 2.1% in 2016, the same situation of 2011, and 11% of the population is not reached by treated water.
  - Moreover, actual national renewal rate is 3.8 meters of pipelines per km of network: this means that at this rate it would take over 250 years to replace it entirely. Today, per-inhabitant investments are €41 per-year, whereas the European average is about €100. [29]

A third trend is related to the growing importance **of innovation**. To this extent, public utility services – in particular mobility, energy and water sectors – are experiencing a transition towards **digitalisation, technological integration and data-based solutions**.

- In the energy sector, modular solutions include smart sensors and actuators that, distributed along the power grid, ensure stability, while optimising energy efficiency according to local requirements. These platforms, based on **data collection and analytics**, enable a secure integration of renewable energy sources, allowing energy suppliers to increase their RES use, with the assurance that system controllers will maintain grid stability.
- Similar technologies have been developed for tackling water leakages: monitoring sensors are more and more digital and organised in "districts", providing a clearer view of the real problems for this infrastructure, thanks to **integrated systems** analysing a larger amount of data and information.
- In the mobility sector, **transport automation** will be an increasingly important trend linked to digitalisation and smart solutions. At the moment, technologies for autonomous driving are too early stage to have real visibility and large-scale application in individual mobility, while rail transport promises to embed extensively such disruption in the medium term thanks to sensors, routines, artificial intelligence (AI) and integrated systems leveraging on data produced in a ringfenced and segmented traffic environment. A widespread and comprehensive adoption of metering and cameras to collect data is key. First solutions of automated metro have already appeared in Italy exhibiting the capabilities to revolutionise not only transportation, but also urban development, industrial decisions and behaviours of passengers.

26 Electricity price in Italy raised by 23% from 2013 to 2017, reaching 0.234 €/kWh, whereas EU average is 0.148 €/kWh. Price reduction targets are in accordance with the objectives imposed by the SEN. Source: The European House – Ambrosetti elaboration on Eurostat data, 2019.

27 Considering storage technologies and future trends, batteries will not generate the highest profits, but the services themselves.

28 Source: The European House – Ambrosetti elaboration on GSE and Politecnico di Milano data, 2019.

29 Source: The European House – Ambrosetti elaboration on WHO and Istat data, 2019.

Moving from technologies to models, a fourth trend is related to the **rationalisation of existing processes, platforms and models**.

Nodes increase their relevance (cities, intermodal hubs, ...) within the services and transport grid, bringing implications in terms of planning, investments prioritisation, stakeholders' involvement and organisational and operational models.

Data economy also enables **customer-centric models**, with consumers acquiring the possibility to actively participate to urban servicing and processes.

- While in the past citizens' role was mostly that of a passive subject (dedicated to the consumption of standardised goods and services, not very active with respect to the initiatives of public administration and industry), with the development of Smart Infrastructures the citizen/consumer is transformed into a **pivotal stakeholder**, aware of his own needs and active within co-creation processes.
- The citizen who is engaged in the production and consumption of goods and services is called **prosumer**: this term refers to co-production for oneself – satisfying own needs – and the awareness of a role as an active citizen with a political and social meaning.
- The prosumers logic is evident in some economic activities carried out by civil society in concert with the public administration and private subjects: examples can be the sharing of information (such as big data) to improve services, or meet mobility needs with car sharing services, or the self-production of energy through smart grids, storage batteries and photovoltaic panels.

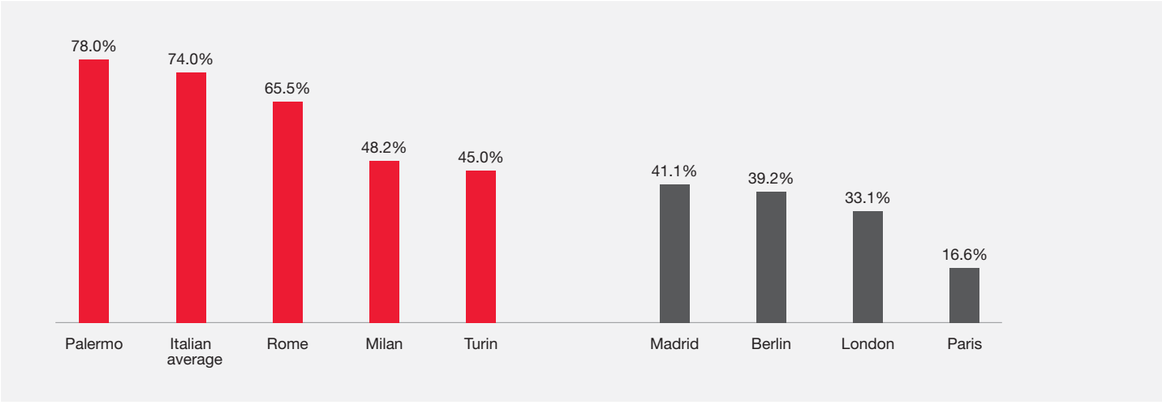
A second technology-enabled model change is the so called "**sharing economy**", particularly relevant in mobility.

- Since 2013, in Italy the number of vehicles available to share has increased fivefold, the service supply has grown with a CAGR of 17% and at present more than 18 million Italians would have the possibility to use this service in their everyday lives, corresponding to 28% of the population. The service flaw is its limited of capillarity on the territory, since 90% of the supply is concentrated in just four cities. [30]
- Sharing mobility diffusion is also linked to electrification (and sustainability), as in Italy its growth is sustained by shared vehicles at zero emissions. The number of electric vehicles in car sharing services grew by 3.5 times from 2015 (620 electric cars or scooters) to 2017 (about 2,200). [31]
- Shared mobility solutions are assuming great importance as an alternative to the individual use of private cars in largest urban areas. This development can favour the planning and deployment of the integrated mobility system according the so called "**MaaS paradigm**" ("Mobility-as-a-Service": the integration of various forms of transport services into a single mobility service accessible on demand).

Mobility is an ambit where benefits from technology-enabled model changes and rationalisation of infrastructures and operational frameworks promise to be particularly vast. A rethinking of Italian urban and national mobility paradigm is in fact needed and should remain a priority for all the stakeholders involved in urban planning.

In this sense, consensus on the need to develop a viable **alternative to the auto-centric model** – that has characterised Italian transportation since today – is evident.

Figure 10: Share of individual transport (car and motorcycle) on total travels in the principal Italian and European cities (percentage on world total), 2017. Source: The European House – Ambrosetti elaboration on 'Il Futuro della Mobilità Urbana' research by The European House - Ambrosetti, 2019.



In this transition, cities will play a key part. In cities, different mobility solutions are available and economically viable. Moreover, urban areas are the key nodes for the inception of a national intermodal platform for both people and freights. To do so, urban development must embrace an overall strengthening of public transport solutions, favouring those options that are easier to electrify and automate.

Railway and metro transportation have to become the cornerstone of a national intermodal strategy, due to the fact that such solutions allow to connect urban and extra-urban nodes via intermodal hubs, also providing effective alternatives for urban mobility (metro, tram, ...). Moreover, rail transport is already sustainable, electrified and characterised by high automation potential in the medium term.

Survey results confirm the relevance of rail transport for effective intermodal deployment in Italy, with major priorities recognised in extra-urban rail development (64% of the respondents indicated it as one of the top-three priorities for intermodality development), deployment of intermodal hubs (61%) and public – private integration (54%).

In this context, the main obstacles for an effective development of intermodal solutions revealed by the surveys lie in the infrastructural legacy of the country (the share of stakeholders including this issue as one of the main three obstacles is 75%), and in the legislative framework not incentivising the coordination between public and private actors (64%).

As already stressed in the paper, meaningful and long-term dialogue between different economic actors is fundamental for the development of such important but complicated solutions.

As a consequence, long-term planning and adequate infrastructural investments (such as in intermodal hubs, strengthening of commuter suburban transport and Intercity railways, smart metro solutions, ...) remain pivotal, together with the capability of the different stakeholders involved in urban planning to cooperate and co-create integrated services and solutions. Within this context digitisation is a key enabler: it allows a more coordinated use of existing data and provides a clearer picture of the real users' needs. The aim is to give citizens and enterprises a broad transport portfolio, a basket of options based on real-time information. [32]

30 Milan (43%), Rome (24%), Turin (15%) and Florence (8%).

31 Source: The European House – Ambrosetti elaboration on Fondazione per lo Sviluppo Sostenibile, Ministero dell'Ambiente and Osservatorio Sharing Mobility data, 2019.

32 An example of a digital solution that can favour intermodal transportation through data exploitation is a software for traffic diagnostic. The Sustainable Mobility Lab of Enea, within EU-funded project Pegasus, has developed STREET (Short-term TRaffic Evolution forEcasting Tool), a software for road traffic diagnostics forecasting its evolution in a period of time between 15 and 60 minutes. The tool is capable to operate both from data collected by widespread networks of fixed traffic sensors, and from estimates based on the processing of anonymous GPS position data transmitted by vehicle fleets in motion, incorporating a set of data-driven models with different degrees of complexity.

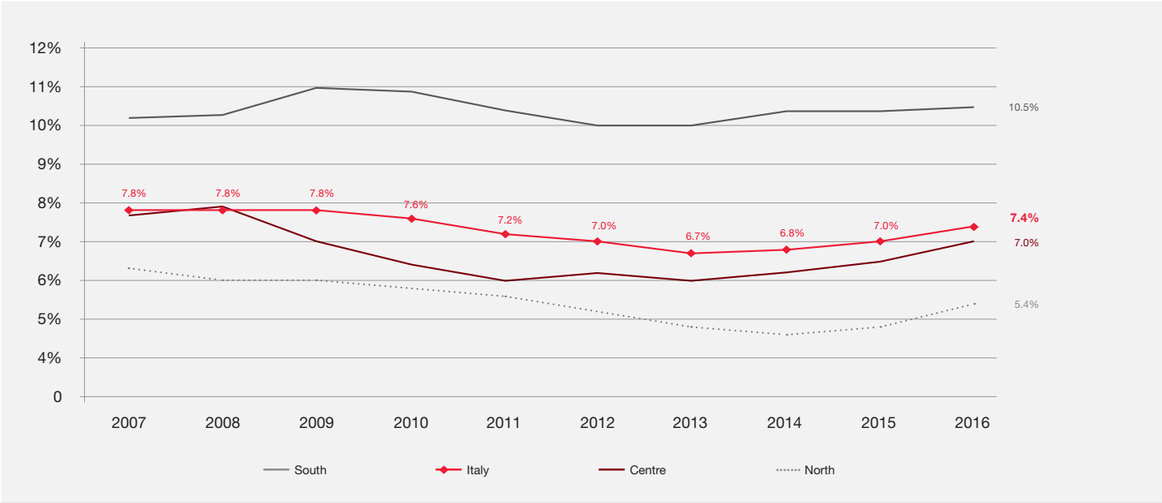
04 Key issues and challenges

Abovementioned transformations unavoidably bring **issues and challenges**. These must be addressed to proceed towards a sustainable and inclusive development of Italian "Connected Cities". The goal of this chapter is hence to investigate such obstacles and burning points before explaining which role technologies and business models can have within a proper and effective deployment of Smart Infrastructures in Italian cities.

A first point of attention is related to **social costs** coming from developments discussed in the previous paragraphs. These should be minimised, especially within an approach that involves citizens, including them at the core of urban development strategies, initiatives and services.

Social costs come from **asymmetric development** of Smart Services, that in Italy is an actual risk. On the one hand, distinctive features and technologies related to Smart Infrastructures could help to reduce imbalances. On the other, if not managed carefully, they could create further disparities and gaps. Major fractures can occur along existing friction lines:

Figure 11: Italian households declaring considerable difficulties in accessing to at least three essential services, 2007-2016 (percentage on total population). Source: The European House – Ambrosetti elaboration on Istat data, 2019.



- **Northern and Southern Italy**. Other than strong inequalities in poverty indicators (the share of population living with an income under the relative poverty threshold is 11.2% in the North, rising to 36.5% in the South), there is a large gap in terms of service accessibility: in 2016, 5.4% of Northern population declares to have considerable difficulties in accessing to at least three essential services (-1 percentage point with respect to 2007), while in the South the share rises to 10.5%, also increasing from 2007 by 0.3 percentage points. [33]

- **Urban vs. non-urban areas**. Residents of Metropolitan Cities have grown by 5.2% from 2012 to 2016 compared to the Italian average of 1.8%. Similar trends can also be observed with reference to the economic dimension: in same period the added value per inhabitant in Metropolitan Cities recorded an increase of 1.5% compared to 0.2% in the rest of the country. [34] In this context, by focusing investments in urban areas, Italy risks to leave behind citizens living in rural or more fragile areas, worsening their conditions. The dominant concentration of innovative services in limited large urban centres threaten to widen the gap – significantly marked already – in the availability and use of novel solutions.

- **City centres vs. peripheries**. Within urban areas, development plans should also pay attention to peripheries and urban voids, with transportation services playing a crucial role. Urban fragility is different with respect to the rural one because it tends to concentrate in the same spaces, frequently in peripheries: this creates entire urban districts predominantly inhabited by households with limited or nil access to essential services, determining factors for the replication of segregate mechanisms and for the long-run perpetuation of impoverishment processes. Share of citizens which declare to have a few or medium difficulty to reach one or more public services is 27.4% in Metropolitan City centres in 2017, vs. 31.7% of suburban areas. Moreover, the household share reporting several problems in accessing to public transport and efficiently connecting to other districts in the Metropolitan City is 7.7% for inhabitants of the city centres and almost double (14.6%) for suburban residents. [35]

Social costs also arise from **digital divide**. Development of smart models that heavily rely on technologies can cause the digital exclusion of those individuals that are not able, or less capable, to keep pace with digital progresses. This is a tangible risk in an ageing country as Italy: [36]

- **Scarce digital literacy** levels in the country is leaving several groups of the population behind, as one-third of Italian households does not have access to internet and has poor or even null competences in the use of computers.

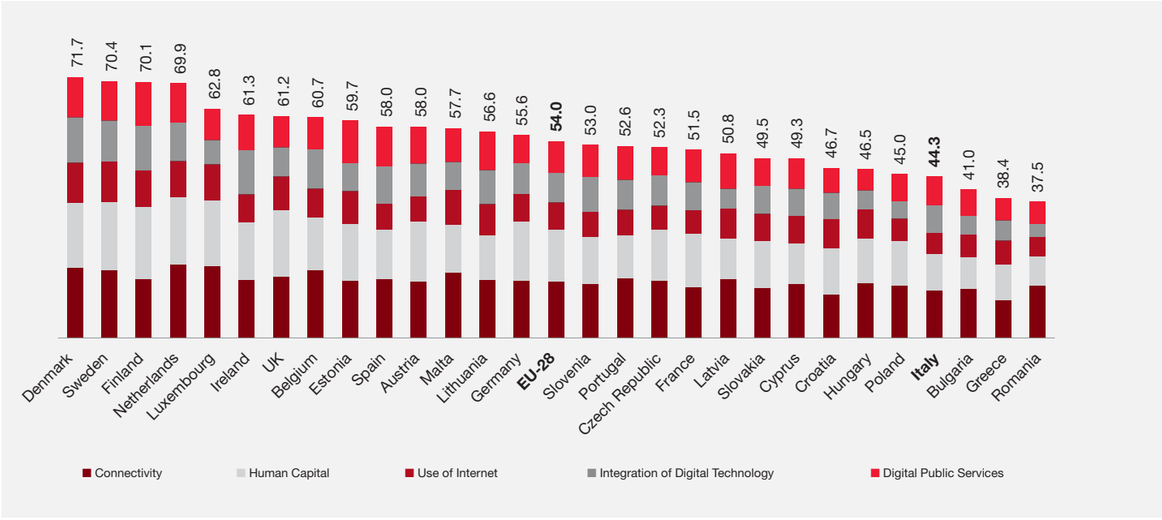
- To confirm this, Italy places **antepenultimate in EU according to the digitalisation index** [37] , with a score of 44.3, while the European average is 54.0. [38]

- As of today, 60% of Italian population does not use infomobility devices associated to public transport. [39] The figure is inevitably related to the age of citizens and, to a lesser extent, to the size of the municipality of residence. Therefore, these population groups would be cut off from the access to the hyper-digitalised infrastructure innervating the new system.

- Even Italian companies display poor digital skills: more than 88% of Italian companies possess a low (or very low) digitalisation, with peaks of more than 90% in the South. Moreover, only slightly more than 50% of Italian employees regularly use a PC, and about 10% of Italian companies receive online orders. These two data reflect the need to integrate the acquisition of ICT capital through the development of new practices and the training of new skills for staff. [40]

33 Source: The European House – Ambrosetti elaboration on Istat data, 2019.
34 Source: The European House – Ambrosetti elaboration on Istat data, 2019.
35 Source: The European House – Ambrosetti elaboration on Istat – Commissione per le Periferie data, 2019.
36 Italian population has average age of 44.4 years in 2017, about 4 years more with respect to 25 years ago, and higher with respect to EU average, that is 42.9. Forecasts indicates that this situation will worsen in the next decade.
37 The digitalisation index (full name: Digital Economy and Society Index) is composite index summarising relevant indicators on Europe's digital performances, that are: connectivity, basic digital competences, internet use and enterprises/public administrations digitalisation grade.
38 Source: The European House – Ambrosetti elaboration on European Commission Digital Scoreboard data, 2019.
39 Source: The European House – Ambrosetti elaboration on Audimob data, 2019.
40 Source: The European House – Ambrosetti elaboration on Obiettivo Crescita research by The European House - Ambrosetti, 2019.

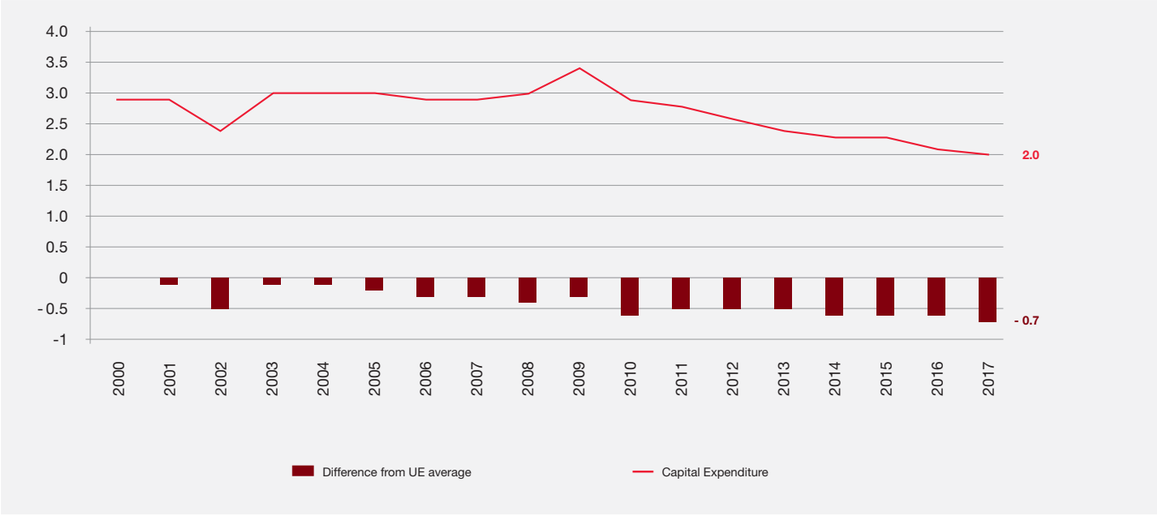
Figure 12: Digitalisation Index in the EU (composite index), 2017. Source: The European House - Ambrosetti elaboration on EC Digital Scoreboard data, 2019.



A second point of attention is related to **resources and funding** for Smart Infrastructures and smart services projects. Resources available to public players are more than ever **limited, particularly at local level**.

- Public investments in Italy strongly decreased as a percentage of GDP: 3.4% in 2008 vs. 2.0% in 2017, meaning lower cumulated investments for more than €124 billion.
- The same applies for private investments: in 2008, the share on GDP was 20.0%, diminished to 15.5% in 2017, a cumulated value of €488 billion.
- Investments in infrastructures are also decreasing: from 2008 to 2017, capital expenditure in Italy constantly declined with a CAGR of -3.8%.
- Comparing investments data with other EU countries, Italy positions itself as third from the bottom for capital expenditure, investing 2.0% of GDP in 2017 (vs. 4.6% of Sweden, 3.4% of France, 2.7% of United Kingdom and 2.7% of EU average), only higher than Ireland (1.9%) and Portugal (1.8%), and experiencing the highest difference in percentage points in the period with respect to the EU average, -0.7 p.p.

Figure 13: Capital Expenditure as a percentage of GDP and difference in p.p. with respect to EU average (percentage of GDP and percentage points), 2000-2017. Source: The European House - Ambrosetti elaboration on Eurostat data, 2019.



- At local level, investments have suffered from a steady decline in the last years: from 2007 to 2015 (latest year available), expenditures in construction, purchase and maintenance of goods in provinces and Metropolitan Cities decreased with a CAGR of -9.7%, while in municipalities with a CAGR of -3.3%. [41]

The surveys significantly confirm this issue:

- Municipalities – and public authorities more in general – consider budget constraints as the principal obstacle to the development of efficient policies and solutions, and to the satisfaction of citizens' exigencies at best.
- At the same time, service providers, start-ups and complementary technological players agree on the fact that a lack of adequate financial public support negatively influences the already slow pace of change.
  - In the mobility sector, 64% of the stakeholders comprises budget constraints/lack of adequate funding as one of the three priorities for an efficient development of electrification.
  - The same applies for intermodal paradigm progress: 61% of the respondents considers public budgets/lack of adequate funding a burden for their deployment.

Economic requirements are made even higher by the need to **update or replace existing infrastructures** to avoid bottlenecks in the system or other legacy-related constraints. Among the others, most noticeable are:

- **Inefficient buildings**: about 3 Italian buildings out of 4 have over 30 years and 56% of them display the worst level of Energy Class (G). In 2017, just 4% of building renovation investments are aimed at energy requalification activities €3.7 billion), despite the data almost doubled (+78%) since 2009.
- **Old water grids**: in the water network, 60% of the national infrastructure has been installed more than 30 years ago (the percentage becomes 70% in large urban centres) and 11% of the population is not reached by treated water. Per-capita investments in water grid and related services is €41 in 2017, whereas required investments to cover the total national demand equals €80, a total of €5 billion per-year.

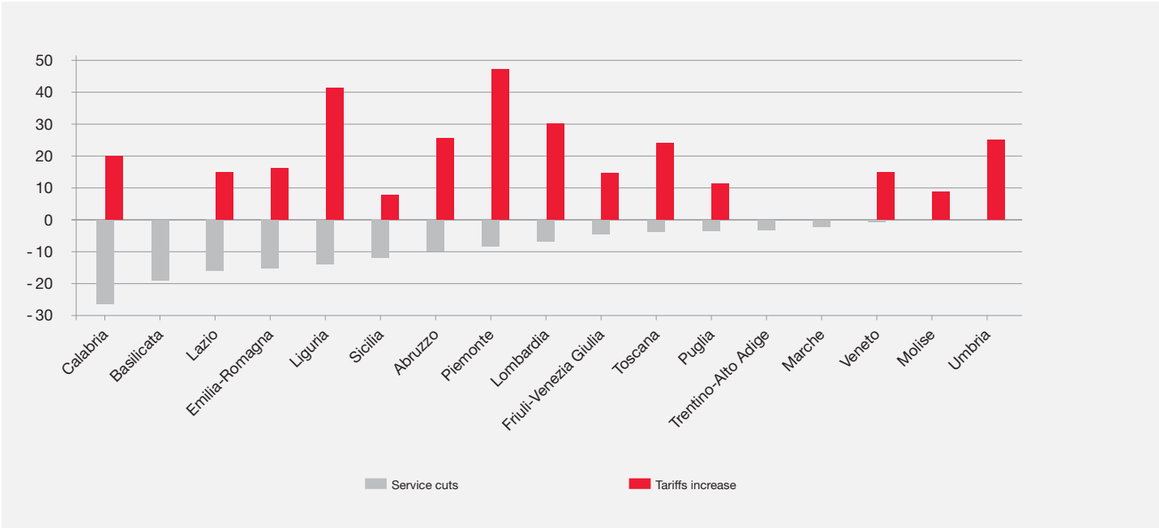
41 Source: The European House – Ambrosetti elaboration on Eurostat, OECD and Istat data, 2019.

- **Fragile and old roads and related infrastructures**: Italy is one of the worst countries in terms of investments level in roads (fourth from the bottom in OECD countries as a percentage of GDP: 0.31%), at the same time not investing in proper related infrastructures. Spending in road infrastructures also decreased by 62% from 2007 to 2016.
- **Limited and old mobility hardware**: considering rail infrastructures, Italy displays a gap with respect to the rest of EU countries, having a suburban rail network of 10.7 km per million inhabitants, in comparison to the 25.2 km of Germany, 26.4 km of United Kingdom and 30.8 km of Spain. The same applies for the metropolitan grid, which accounts for 3.8 km per million inhabitants in Italy, in comparison to the 7.8 km of Germany, 10.5 km of United Kingdom and 12.5 km of Spain. Similarly, the tram grid is 5.3 km per million inhabitants in Italy, 11.7 km in France and 23.3 km in Germany. Looking at buses, the average age of an Italian vehicle is 11.4 years, compared to 7.8 years of a French bus, 7.6 of a British one and 6.9 of a German one, with evident consequences in terms of polluting emissions and high maintenance costs. [42]

In this sense, the case of Italian commuters deserves particular attention. The situation experienced every day by those who take the train for work or study reasons reflects the image of a country that increasingly travels at different speeds. National connections [43] show success of modern and fast trains; on the other hand, the progressive reduction of regional trains can be observed in parallel, with service cuts and an increasing degradation of supply, characterised by slow and outdated trains.

These are major reasons that explain the low share of 5.4% of Italian population ordinarily using rail transportation, and the fact that 96% of rail commuting takes place within the 14 Metropolitan Cities. [44]

Figure 14: Service cuts and tariffs increase in regional train services in Italian regions (percentage variation), 2011-2016. Source: The European House – Ambrosetti elaboration on Ministero delle Infrastrutture e dei Trasporti data, 2019. [45]



The urban sprawl has widened metropolitan areas, moving residence sites away from the poles of work and services, and urbanising areas poorly connected to the network of public services. Daily covered distances to reach the workplace increase: in Rome and Milan the average commuting time is more than 45 minutes, similar to the 46 of a much larger and high-traffic city, New York.

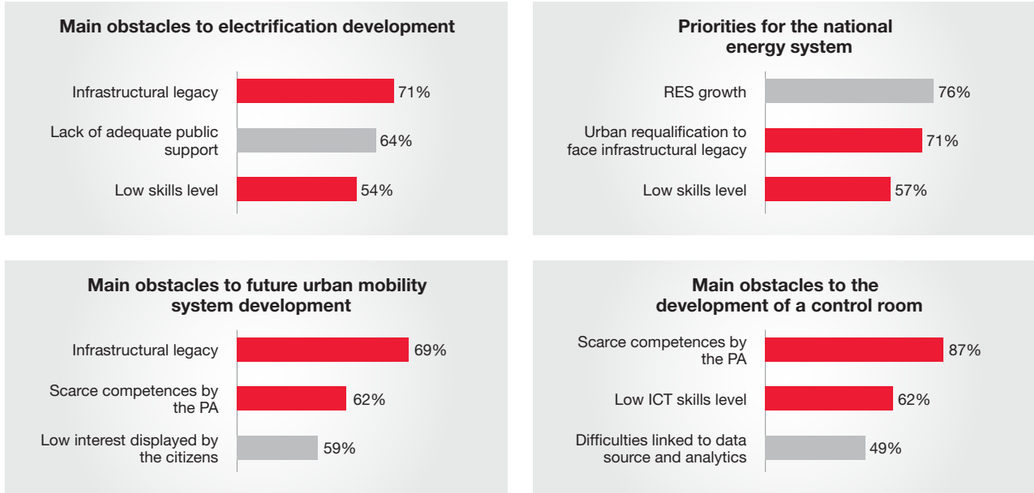
The lacks in the railways system also brings to a scarce train use for freight transport. As the scenario chapter previously outlined, railways share in total multimodal split for freight is 3 percentage points lower with respect to EU average.

This is confirmed by the results of the surveys: infrastructural legacy is always positioned as the first or one of the main obstacles for an effective large-scale implementation of novel technological solutions (e.g. autonomous driving, electrification, water districts installation, etc.), as Figure 15 will show.

Inadequate economic resources and infrastructures are also accompanied by **scarce skill level** within the overall labour market. Nowadays, supply and demand struggle to meet when considering functions characterised by a high-level of ICT skills, such as data scientists. In Italy, university graduates majored in ICT are 1.1% on the total (lowest share among OECD countries), while 13.5% is graduated in STEM (Science, Technology, Engineering and Mathematics) disciplines, lower in comparison with the average of OECD countries: 19.1%. [46]

Companies and public administration are perceiving this shortage of adequate competences, and this has been highlighted in the surveys, but at the same time there is also a sensed lack of proper incentivisation and appropriate educational programs proposal in our country.

Figure 15: Answers to survey questions (percentage share of respondents' selections: three out of eight/ten options selectable), 2019. Source: The European House – Ambrosetti elaboration on surveys' results, 2019. [47]



42 Source: The European House – Ambrosetti elaboration on Istat, Cresme, Enea, Eurostat, OCED, Utilitalia and 'Il Futuro della Mobilità Urbana' research by The European House – Ambrosetti, 2019.
43 The so-called "Alta Velocità".
44 Source: The European House – Ambrosetti elaboration on Legambiente, Istat and Eurostat data, 2019.
45 Service cuts data for Molise and Umbria, and tariffs increase data for Basilicata, Trentino-Alto Adige and Marche are not available.

46 Source: The European House – Ambrosetti elaboration on OECD data, 2019.
47 Other options were the following. Main obstacles to electrification: low investments, lack of adequate and sufficiently mature technologies, difficulties in the planning phase, regulation, coordination among public and private actors. Main obstacles to future urban mobility system development: scarce funding levels, coordination among public and private actors, hindering legislation, lack of adequate technologies, scarce data integration. Priorities for the national energy system: management of the electricity grid to face growing urbanisation and demand, energy price and cost reduction, develop predictive maintenance and real-time feedback solutions, invest in storage technologies, invest in consumption monitoring systems at private and district level, invest in cogeneration and district heating, reduce energy consumption. Main obstacles to the development of a Control Room: high costs, compliance to GDPR and other regulations, lack of adequate technological solutions, absence of private innovative partners helping with the transition, identification of a managing body, contrary public opinion.

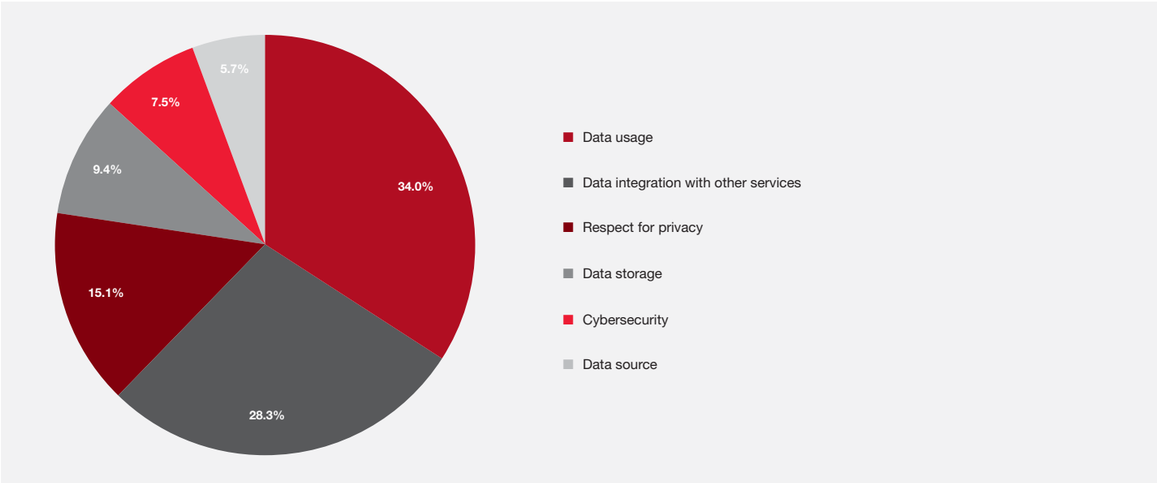
An additional point of concern is related to the **growing importance of data**, probably the most important "enabling asset" required to create and deliver "Smart Services". [48]

- Data have reached such a paramount importance that a whole new industry is growing, the so called "**data economy**". It is currently worth €60 billion in the EU alone and is expected to grow between €80-€110 billion by 2020. [49] This value doubles the one of Japan and is half of the United States. [50]
- The growth of data traffic (Big Data), together with the spread of new forms of remote storage (cloud), raises the necessity to **preserve and conserve** this strategic resource for its use and analysis (Big Data Analytics).
- For this reason, physical **infrastructures** used to host servers and the latest generation of data storage and analysis solutions are becoming increasingly essential. Data centres also play a central role in terms of data storage quality, security and integrity.
- **Cybersecurity** represents a major concern for public authorities, players and citizens: at a global level, 25 million data breaches occur every day, and 4% of these happens in the EU. Moreover, in 2018 the cybersecurity market surpassed the value of €1 billion in Italy.
- With the stock of information available in real-time and for the analysis, the pervasiveness of data collected increases, together with their ability to return private information. Challenges therefore arise in relation to **privacy**, individual rights protection, ownership of data, their portability, integrity, security and preservation, other than the instruments suitable for regulating this new resource and for enhancing its value.

Data-related issues also highlight the **role of regulation**, and the difficulties it has in keeping up with fast and disruptive technology advancements. In this sense, the **General Data Protection Regulation (GDPR)** [51], approved in 2018 by the European Commission, takes its first steps in the field of privacy protection for individuals and the interoperability of data. The very nature of this resource, intangible and pervasive at the same time, poses a twofold problem today, still far from an effective solution: to protect individual rights without precluding competitiveness and economic growth.

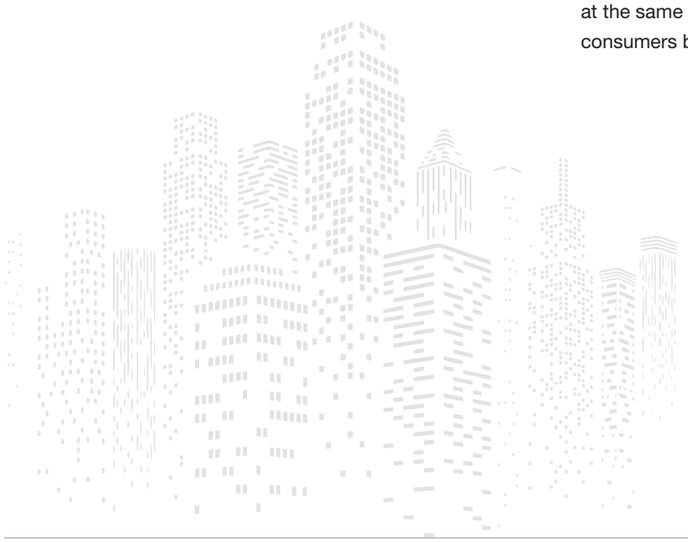
The GDPR regulation, although innovative, risks to place significant constraints on the full integration among data originated by different sources and users by creating silos and limiting visions and systemic solutions. Such concerns are confirmed by survey respondents.

Figure 16: From which standpoint do you think to meet the most critical issues related to data regulation (GDPR)? (percentage on total), 2019. Source: The European House – Ambrosetti elaboration on surveys' results, 2019.



GDPR is one example of the increasing **regulatory pressure** occurring nowadays in Italy and Europe. Latest forecasts expect that the adaptation cost to the GDPR of Italian companies is around €2 billion: in terms of a single company, the average adaptation cost was €350,000 in 2016 and €480,000 in 2017. [52]

Another example of this kind of adaptation is linked to **environmental regulation**: pollution is putting enormous pressure on the legislative framework delineating in the last years. For example, the new EC Directive imposing stringent standards for CO_2 emissions in the transport sector will cause an increase of production costs in the automotive industry by 6%, at the same time rising vehicle purchase costs for the consumers by €1,300. [53]



48 A more in-depth analysis of these aspect is carried out in the paper concerning Smart Safety.
49 Considering indirect and induced effects the value reaches around €300 billion.
50 Source: The European House – Ambrosetti elaboration on EC data, 2019.
51 The General Data Protection Regulation (approved by the EC on 25/5/2018) is a EU regulation on data protection and privacy for all individuals, aiming at giving control to individuals over their personal data and to simplify the regulatory environment for businesses by unifying the legislation within the EU.

52 Source: The European House – Ambrosetti elaboration on Confesercenti data, 2019.
53 Source: The European House – Ambrosetti elaboration on Anfia data, 2019.

05 Role of technology and organisational models

Technological solutions currently available can help Public Administrations and other players involved in Smart Infrastructures' development and management to win the abovementioned challenges, pursuing efficiency, sustainability and meaningful innovation. >

The main technology-enabled element is the Connected City's architecture, the so-called **Urban Control Room**. It constitutes the horizontal framework where data originated by several sources (citizens, infrastructures, vehicles, utilities, local public transport agencies, houses, appliances, ...) are collected, analysed and turned into valuable assets: information. Such information (KPIs, analysis, metrics, …) are then supplied to service providers (utilities, TPLs, citizens, other services' providers, infrastructures' managers, …) to design and run smart vertical services.

The Control Room collects data from multiple sources (mobility, energy and water systems, citizens, …) and **integrate them in a single platform**. In this sense, public control of urban Control Room allows to maintain privacy and safety of data, reducing ownership issues. Moreover, the assurance that raw data are kept under public control, and only aggregated information are shared with other service providers and private player, incentivises cooperation of all stakeholders. Local public transport agencies, utilities, and communities are less concerned about losing control of their own data or to sell out competitive advantage, also benefiting from better services and useful information. [54]

- An example of the potential of Urban Control Rooms comes from data collection from city cameras that, positioned in strategic places as intermodal hubs (e.g. a central station), provide heterogeneous data on volumes and typology of users crossing these places or travelling in determined times and occasions. An integrated Control Room allows to create value added information thanks to the integration of such data, supporting the delivery of **Smart integrated mobility Services** (predictive distribution of fleets, adaptive scheduling of routes, real time alerts to travellers also improving safety, geo-location-based services to businesses, …).

54 Please refer to "Smart Safety" study for in depth analysis of privacy outcomes coming from integrated urban control rooms.

This Control Room is considered a key priority for the next future for the stakeholders involved in the survey (47% of respondents). At the same time, another considerable proportion of respondents (31%) is not aware of the potential benefits or does not consider it a priority in the near future.

To avoid technological or infrastructural legacy, this integrated platform should be carefully planned since the very beginning, encompassing full **scalability and flexibility**. Initial design choices should not affect the possibility to build new and innovative vertical smart services over time or to integrated new data sources or analytics' software.

Within this framework, city and citizens' data are the cornerstone and the most valuable asset for city managers. Such data are managed, aggregated and analysed within the integrated horizontal framework provided by the Urban Control Room, then converted into valuable KPIs and information that feed urban Smart Services. To do so, **Big Data analytics** is crucial, as the value extracted from collected data directly depends on the quality of analysis on large, integrated datasets. Data analytics keeps evolving worldwide, with a market growth between 2011 and 2017 resulting in a CAGR of +29% and expected to surpass $100 billion value within 2027.

Figure 17: Functioning of the Integrated Control Room (illustrative). Source: The European House - Ambrosetti elaboration on interviews and survey results, 2019.

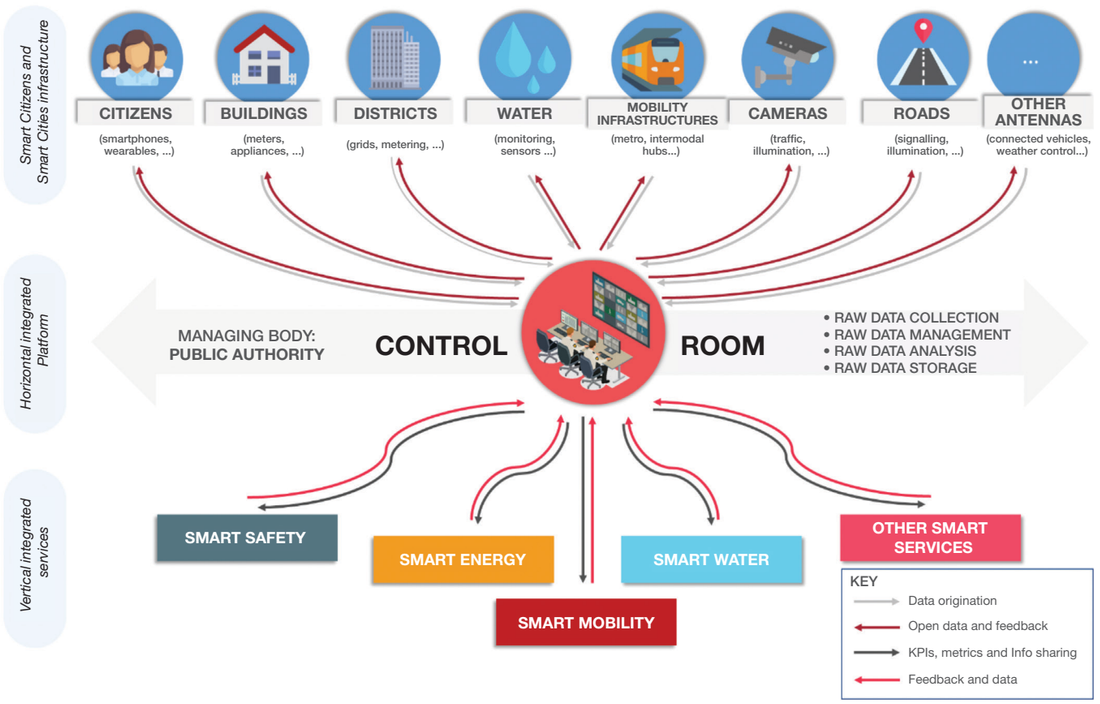
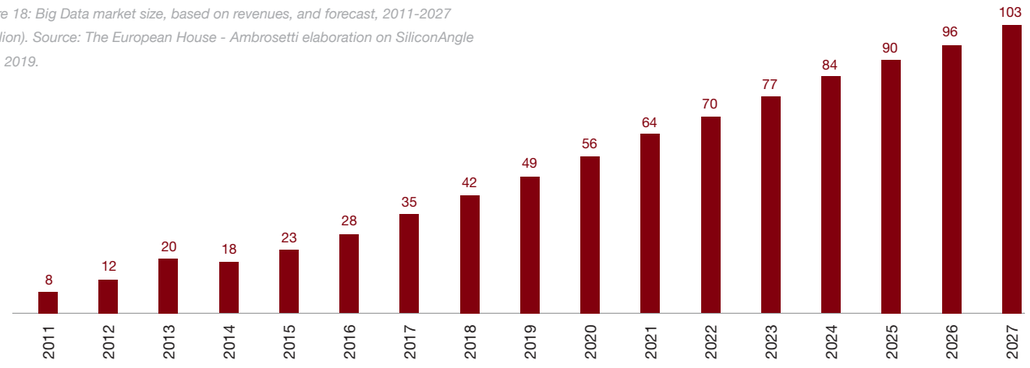


Figure 18: Big Data market size, based on revenues, and forecast, 2011-2027 ($ billion). Source: The European House - Ambrosetti elaboration on SiliconAngle data, 2019.



Real time analysis and accurate predictive forecasting depend on the quality of analytics' software, that are extremely valuable solutions in dealing with urban services such as public transport and energy and water management, where timing actions remain crucial. In this way, organisations are capable to quickly respond in order to mitigate issues, especially in the case of time-sensitive criticalities.

At the same time, forefront analytics allows to deliver knowledge, metrics and information to actors in the system in a simple-to-understand and useful way, reducing the impact of digital skills' shortage in Italy. Big Data analytics are fundamental also for businesses and citizens, as they help to better identify, measure and understand performances in real time, together with consumption habits, costs' centres or root causes of errors.

- Thanks to real time information from integrated urban mobility data, the **MaaS paradigm** can see its concrete diffusion, making transportation more and more organised around the service offered, rather than the mean utilised. An effective implementation of MaaS could benefit from data-based integration of transport means, optimised travel solutions and transport mix, increased flexibility of the overall urban mobility system, adaptive fleet management, timely reaction to customers' journey, delivery of easy to understand alerts and information to customers.
- Precise forecasts on hard storms hitting a determined area can timely alert competent bodies in water, energy and mobility management systems of possible criticalities. In this way, sensitive road infrastructures (e.g. bridges) can be promptly closed, emergency solutions can be adopted to efficiently manage water grids, storage systems can be activated to face possible electricity blackouts, while citizens at risk can be warned through smartphones or other devices.
- Due to their unpredictability, the growth of renewable sources should be accompanied by a careful analysis of related data. In this sense, data integration when dealing with RES implementation in the electricity grids relies upon information as weather forecasts and analysis on energy prices, even at a European level (energy union).
- The combination of metering and advanced analytics enables the deployment of **predictive maintenance and real-time feedbacks**. Through advanced algorithms and machine learning principles, it is possible to anticipate criticalities in the infrastructures or vehicles, and to design optimised and cost-effective maintenance plans or fleet-rotation programs.
- The possibility to monitor water grids with real-time monitoring sensors, integrated with solutions of data analytics, allows a ready prevention of leakages along the water network, increasing efficiency, stability and safety of the water supply and cutting operating and maintenance costs.
- ICT solutions to counter leakages on water supply and management systems have been implemented in areas plagued by high rates of non-revenue water.[55] By combining monitoring systems with simulation analysis technologies, cost-effective leakage management systems can be achieved, reducing the time that elapses from the leakage discovery to countermeasures implementation. Several urban areas are already benefitting from these technologies. For instance, systems installation in different Japanese cities has allowed the municipalities to reduce grid management costs by 8%.[56]

Such solutions can provide several benefits including: reduction of costs and downtime, improvement of overall assets' efficiency, improvements in operational efficiency, increased safety, higher lifetime value, sustainability. These elements are particularly important for Public Administrations, service providers, and complementary technological companies. In the end, they also translate into better services and experiences for citizens.

Increasingly high performances and results in forecasting and real time analysis of integrated databases will be possible thanks to **Artificial Intelligence and machine learning** technologies. Investments in this field are already high and will grow exponentially: expenditures on cognitive and Artificial Intelligence systems will reach $77.6 billion globally in 2022 with a CAGR of +37.3% over the period (more than three times the $24 billion expected in 2018). Italy is among the countries where such technologies can deliver the highest benefits.[57]

Artificial Intelligence promises to yield high returns in fields such as mobility, with autonomous driving solutions in private and individual transportation today under development. Once at full scale, the promotion of such systems will bring to disruptive changes in overall urban mobility, and must be kept into account in the design of integrated platforms and services.

- Autonomous driving would represent a **hybrid system halfway between public and private** transport, which in turn would facilitate the reduction of vehicles in circulation, traffic in urban areas, and infrastructures as parking areas surfaces, with great urban management and environmental benefits.[58]
- Today, on average, **a private car is kept in motion for only 5% of the time**, while the remaining 95% is unused and parked. A shared autonomous car – certainly electric – would work differently, constructing rides and routes according to the requirement of different users.
- The implementation of autonomous driving in the MaaS model would allow private operators to design and operate **new integrated transport services** (e.g. integrated car sharing), while the public would have the task of updating the legislative framework and directing collective priorities towards this kind of solutions, also extremely important in the public transport systems (autonomous train, underground, etc.).
- Other than the abovementioned gains, expected benefits from the development of autonomous driving lie in the **safety increase**, both for direct users (drivers) and other road users (e.g. pedestrians).

If autonomous private transport is technologically complex and just predictable in the long term, in public collective transport it is already available, especially when considering **rail transportation**.

- Efficient and effective autonomous driving urban transport, as the **driverless metro system**, can significantly contribute to achieve socio-economic and environmental objectives, by contemporarily bringing practical solutions, as short headways (up to 60 seconds for Milan's metro), greater flexibility and service level (adapting the service frequency to real-time demand) and higher commercial speed.
- In addition, driverless systems considerably **reduce operating costs** (by up to 40%), at the same time enhancing the level of safety and service quality.
- The increasing service attractiveness will also permit an abatement of **atmospheric and acoustic pollution**. Considering the case of Milan M5 Metro, it is estimated that the solution at full capacity will lead to 15 million annual shifts from private car to metro, with a consequent significant decrease in pollutants.

55 Water that does not generate revenues for utilities: in South-East Asia, this share accounts for 30% on total water supply.
56 Source: UNCTAD, Kashiwa-no-ha Smart City, CSTD 2015-2016 Inter-Sessional Panel on "Smart Cities and Infrastructure and Foresight for Digital Development", 2019.
57 Source: The European House – Ambrosetti elaboration on Icom, Istituto per la competitività, "Italy of things Per cittadini e imprese connessi al futuro", 2019.
58 The Boston MIT developed a research based on data from the city of Singapore: it was observed that, in a urban scenario with autonomous cars, parking space could decrease by over 70%, changing the metropolitan landscape.

- Overall, an annual saving of 8,470 tons of fuel and 260 less road accidents per-year in the city are forecasted and for each new passenger using the metro, **1.4 additional passengers use other public transport**, for a total of 2.4 passengers switching from private to public transportation.

Considering hardware, the development of **energy storage systems** is already in an advanced phase. These solutions will increasingly contribute to several positive advancements, including: stabilisation of power supply systems (especially in areas where the incorporation of RES into the grid is crucial for the national energy system), effective deployment of advance electromobility solutions, and energy-efficient water supply and management. As prices decrease and technology advances, improving performances and state-of-the-art reliability open up new opportunities in a multiplicity of ambits.

- Large-scale renewables deployment and implementation projects of energy storage systems are already delivering benefits in terms of frequency regulation and electricity service reliability and lifetime in energy systems. In closed systems, for example on islands, small-scale power grids need energy storage solutions for balancing demand and supply, as well as for electricity utilisation during peak times. This is important due to the unpredictability of renewable sources, which are more and more exploited in energy systems all over the world.

High performance, reliable and cost-effective storage solutions are also a prerequisite for **electromobility** inception in private and public transport. Electrification is one of the prioritised solutions to win urban transportation and environmental challenges, also robustly confirmed by surveys' outcomes.

- On the private side, electric cars are still too costly for medium-class consumers: their price is halting a complete market development. The persistent technological gap is principally related to the lack of adequate **batteries**: this should lead to significant public investment in the exploration and detection of innovative solutions, also financing automotive suppliers.
- On the contrary, electric public transport is getting more and more relevant for sustainable transport strategies in Europe. In this case, better batteries can deliver increased flexibility, improved performances, reduced infrastructural legacy and enhanced customer experience, also fostering **intermodal** transport within cities and between Italian urban and extra-urban nodes.
  - An interesting example of efficient batteries in public transport is found in Florence: the novel electric tram covering urban surface will have lightweight batteries capable of lasting for long routes and fast to recharge – hence eliminating the need of electric poles upholding the infrastructure.

Finally, solutions such as smart meters, sensors, cameras, wearables, connected gears and appliances are the **antennas** allowing data collection within the city. These devices are becoming more and more widespread (wearable devices were 71 million in 2016 and are expected to reach 215 million by 2021)[59], providing an increasing quantity, but also quality of data. These benefits go hand in hand with the improvement of sensors' performances and the development of TLC solutions, such as 5G networks.

Once integrated in the urban Control Room – directly or through utilities and other city players – these meters and devices can also act as receivers of information and KPIs elaborated at central level, boosting the overall integration of the system.

Thanks to smart meters inception, energy networks get revolutionised becoming **smart grids**, solid tools to manage consumption effectively at a district level[60], avoiding wastes, boosting efficiency and enabling RES integration and the streamline along the electricity grid.

Such intelligent energy system also ensures additional energy storage in the case of overproduction (e.g. due to a sunny summer or a windy autumn), which can be distributed to other territories in need or kept in case of necessity. As stressed in the previous paragraphs, declines in electrical power quality are becoming a serious challenge, as larger amounts of renewable energy are introduced to the power grid.

59 Source: The European House – Ambrosetti elaboration on IDC data, 2019.

60 They enable the service provider – in this case the energy supplier – to communicate with users and, on the basis of the information received, calculate where to deliver electricity in the best possible way.

06 Priorities for connected cities development and deployment in Italy

Technologies that are today available would potentially allow to overcome major criticalities and issues related to Smart Safety service provision within Italian cities. Together with technologies, however, **innovative operational and organisational models** are required to create a proper Connected City, putting citizens and communities at the core of valuable and integrated services.

As illustrated in the previous chapters, the main enabling element for the development and deployment of urban Control Rooms is **integration**. It can be achieved only through a real cooperation of all stakeholders involved in urban planning, development and management. Such cooperation should begin in the very initial phases of the creation of a connected city.

To deliver integrated and valuable services and to get the most from a scalable urban control room, its architecture should be **co-designed and co-developed with the cooperation of multiple actors** including Public Administration, utilities, other service providers, technology providers and integrators, funding agencies and, of course, citizens and communities. To achieve interoperability (that is the foundation of an integrated Control Room) shared standards, approaches and languages should be defined and agreed since the beginning.

In this sense, a priority is **training of civil servants and public managers** to update the basket of competences today available, as Public Administrations have a crucial role in the creation of Connected Cities. For this reason, a strong discontinuity is also needed in the way municipal projects are developed and run. Cooperation between different branches and department (also with other local and national levels) is required. Moreover, a cultural change is key, towards a greater drive to innovate.

Within an integrated urban Control Room, Public Administration will have to manage tenders, lead the co-design processes, carry out data collection, management and analysis and then share information. **Technical staff must be competent, fit for purpose and capable to make smart contract development**. Lack of competences, on the contrary, risk to leave the imitative to single utilities or technology integrators, that provide technological gadgets that are useless (or less valuable and effective) compared to a system of integrated vertical services enabled by horizontal platform. Statistical departments within municipalities should also be empowered.

Governance of a Connected City is pivotal and should be defined since the beginning. It should clearly define political and technical roles, including those in charge of strategical development, architectural and infrastructures management, and data protection.

At **national level**, technical frameworks and annexes should be developed, to provide local administrations with adequate guidance, formalised guidelines and standardised models. Such documents should be compliant with international regulation and targets, also encompassing best practices at national and international level.

Cooperation should also apply between public administrations and stakeholders of different cities. While an adequate level of personalisation of architectures and digital solutions is required - given the fact that each city has specific features and needs – common solutions, standards and technological framework between different Italian cities (or international ones) could lead to **lower costs and possibility of licensing**.

Public Administration is hence crucial, it must **lead dialogue and co-design**, providing guidance and clear requests to other players (utilities, technology providers, integrators, communities, ...), sets standards, regulations, targets and priorities since the very beginning. This allows scalability and avoids technological lock in of specific companies or players. It also defines modalities to collect and share data. It provides central intermediation.

However, Connected Cities are not based on centralised processes, but on **horizontal, decentralised and integrated models**. For this reason, all stakeholders should play their part. Dialogue, co-design and co-development is a priority as well. It should include multiple companies: technology providers deploying the horizontal architecture (Urban Control Room), but also technology providers for vertical services and utilities.

A single company cannot build a Connected City. Cooperation is the key. Private players should accept to put own data into the system, reassured by public control of the horizontal architecture and incentivised by the possibility to offer integrated services and to receive valuable information in turn. **Communities and citizens** must participate in co-design, also through new participation channels. They must receive useful data, KPIs and metrics, that transform individuals in prosumers and pro-users of public services, involving them in the co-development of services. Transparency also increase accountability of the overall system.

Finally, **research institutions** (e.g. ENEA) and **funding agencies** must take an active part too. Financing schemes can be extremely effective in incentivising dialogue and co-design of a Connected City, playing a far more effective role than legislation. Through financing schemes, they should incentivise public-private partnerships, open innovation, networking with research institutions and start-ups, guaranteeing cooperation, integration, transparency, and interoperability.

In conclusion, most of the technologies required to create a Connected City are today available. They are constantly evolving and improving. However scalable architectures can be conceived to plug in additional data sources and new software and hardware solutions over next years. As of today, the priority is to **develop innovative organisational and operational models, based on digitisation and co-creation**, including all stakeholders involved in the planning, development and management of cities and urban services.

This is a prerequisite that should **urgently become a priority for Italian decision makers**: without putting in place the operational framework and the mindset for cooperation, it is impossible to create a proper "Connected City" delivering smart services to own citizens. On the contrary, a fragmented and uncoordinated approach risks to put the focus on single solutions or "technological gadgets", that fail to take the most out of digital progresses or, even worse, waste public resources delaying or affecting the capability of urban system to deploy a well-developed Connected City.

Appendix 1

Hitachi solutions for Smart Energy and Water

Hitachi partners today with public and private institutions to design and deliver **concrete and effective technologies** and solutions, capable to enable the inception of Smart Energy and Water services both in Italy and at global level. Hitachi participates in co-creation activities and joint projects to improve sustainability and performances of public utility services through storage systems, smart metering sensors, smart grids technologies and integrated platforms. These technologies facilitate the application of innovative models, transforming consumers in prosumers. Such concrete solutions match product advancements and innovative organisational models with the central idea behind social innovation: **finding solutions not for one person or organisation, but for all of society**. Among the others, examples of concrete smart services solutions include:

CASE STUDY:

Solar power, batteries, smart heating solutions and electric vehicles support a UK island's energy system and reduce bills for its whole community

On the Isles of Scilly, the Hitachi-led Smart Energy Islands project is taking advantage of huge technological opportunities and changes in the electricity market, on a scale not seen since the late-19th century. Working with two of the UK's leading smart home technology companies, Hitachi is installing its **IoT platform to balance electricity demand and supply** on some of the UK's most protected yet carbon-intensive islands. Through collaboration Hitachi managed to reduce the island's carbon footprint, whilst optimising locally-produced and low-cost renewable energy.

http://www.hitachi.eu/en-gb/press/isles-scilly-and-smart-energy-islands-project-update-july-2018

CASE STUDY:

Smart grids to improve Polish power system protection in case of high Renewables penetration

Hitachi Ltd., has carried out a joint smart grid demonstration project in Poland to support the power system security in response to the expanding share of RES connected to the power system. Hitachi contributed with its **state-of-the-art network stabilisation and battery storage technologies**, capable to prevent grid overloading and allowing an optimal management of RES generation, especially wind power.

http://www.hitachi-chem.co.jp/english/information/2017/n_170317g7e.html

CASE STUDY:

Hitachi Water Management System as an IoT tool to derive value from integrated data analysis on the water cycle

Hitachi has developed a system that optimises the water services' management at a centralised level by integrating user data into a single platform. Using IoT technologies and sensors for analysis, visualisation and reporting at the various levels of the production cycle, the Hitachi Water Management System allows to monitor and control water networks, sewerage networks and production and purification plants, as well as to optimise efficiency and timely interventions. The system permits to analyse the performance trend of networks and plants and to identify correlations, trends and opportunities for predictive maintenance using also machine learning algorithms.

CASE STUDY:

Storing renewable energy to fuel Italy's biggest data centre campus

Fiamm Energy Technology and Aruba SpA teamed up to create a **space-efficient solution for storing the renewable energy generated** to sustain the largest data centre campus in Italy in Ponte San Pietro. Thanks to Fiamm Energy Technology FLB battery blocks, which have a long shelf-life and are maintenance free, the novel modular structure guarantees the best use of space as well as straightforward future expansion. This solution enables local communities to enjoy all the benefits of a connected lifestyle and the comfort of knowing they aren't impacting the environment, developing the increasingly important role of prosumers for the energy system.

http://social-innovation.hitachi/eu/case_studies/storing-renewable-energy-an-innovative-solution-for-italys-biggest-data-centre/

CASE STUDY:

Oliena Project: water efficiency and leakage reduction in 30 municipalities in Sardinia characterised by a high level of dispersion

The so called "Oliena Model", a pilot project commissioned by Abbanoa S.p.A. and delivered by Hitachi in close collaboration with the partner stakeholder and local institutions, led to a plurality of interventions that solved the existing issues in Oliena, a village in Sardinia with an aging water network and high levels of water leakages. The project added an efficient stability and improved the overall water supply by prioritising pressure management, air control and prevention of pressure variations. Water losses were reduced by more than 50%. The "Oliena model" is now on the list of Italian Best Practices and has been extended to other 30 Sardinian municipalities, to be followed in the coming years by 200 further municipalities.

http://www.hitachi.eu/en-gb/case-studies/oliena-model-hitachi-water-saving-project-italian-best-practices-list-2017-sardinia

Appendix 2

Hitachi solutions for Smart Mobility

Hitachi already supports safe and sustainable collective transportation within and between urban spaces in Italy and in the world. Suburban commuting is offered through **state-of-the-art, high capacity and flexible platforms**. Within urban spaces, Hitachi metro lines allow cities to provide **safe, cost-effective and intelligent mobility services**. Surface transport solutions match adaptive support to overall urban mobility framework with **limited impact** on urban design and decorum (e.g. thanks to lean and catenary free tram). Digital architectures with forefront analytics' capabilities and horizontal platforms based on shared operational models add. All these technologies together provide the ideal ecosystem to co-develop and deploy **integrated mobility services**, also enabling paradigms such as **intermodal transport** and, in the future, the inception of **autonomous driving**. Among the others, examples of concrete mobility solutions include:

CASE STUDY:

The world largest test of commercial electric vehicles is IoT enabled

Led by global data technology solutions provider Hitachi Vantara and electricity distributor UK Power Networks, the world's biggest trial of commercial electric vehicles "Optimise Prime" will begin in early 2019 and will see up to 3,000 electric vehicles take to the road. Thanks to real-life datasets and Hitachi Lumada IoT platform, the project will create a detailed picture of the demand of electric fleet and private hire vehicles, making possible to develop solutions that cut the cost of owning and running electric vehicles.

https://www.hitachivantara.com/en-us/news-resources/press-releases/2018/gl181130.html

CASE STUDY:

Artificial Intelligence as a tool to achieve sustainable shipping

Hitachi Europe Ltd is partner of Stena Line, one of the largest shipping companies in Europe, to **implement artificial intelligence technology on ships**. The goal is to improve fleet operation across ships and shores, providing new capabilities for safer and more sustainable ferry journeys, as well as helping to improve operational efficiencies and overall vessel performance. By reducing fuel consumption costs through cognitive technologies, Stena line aims to minimise environmental impact and become a leader in sustainable shipping.

http://www.hitachi.eu/sites/default/files/fields/document/press-release/stena_line_news_release_final_0.pdf

CASE STUDY:

Co-development initiative to deliver a fully automated passenger train system

Hitachi and Ansaldo STS are part of a co-development initiative launched by SNCF, within two consortia of suppliers and research institutes that - by pooling their technical and industrial expertise - aim to develop and implement the technology to achieve fully automatic trains by 2023. These partnerships bring together major manufacturers from the railway, automotive, aviation and systems intelligence sectors, as well as players in engineering and artificial intelligence. They enjoy strong support from the public authorities via the French National Research Agency (ANR). All of this expertise will help to advance the driverless train project in key areas such as obstacle detection, signal reading, geolocation, monitoring of the train's environment and hazard management.

https://www.sncf.com/sncv1/ressources/presskit__train_autonome__september_2019_v2.pdf

CASE STUDY:

City-wide driverless metro system for the city of Copenhagen

Hitachi and its subsidiary Ansaldo STS has joined forces with Copenhagen and its Metro company to create a world-class seamless transport system, which fits into the city's current design and infrastructure. The collaboration resulted in a safe, fast and comfortable metro system. Driverless system was introduced. Based on this success, in 2019 City Circle will also open: 16 km of double track and 17 additional stations in operation 24 hours a day with 98% service coverage.

http://www.hitachi.eu/sites/default/files/fields/document/press-release/stena_line_news_release_final_0.pdf

CASE STUDY:

A Hi-Tech solution for clean and flexible urban transport

Hitachi Rail Italy new tram platform is a flexible, full low floor streetcar solution, featuring easy and fast passengers boarding and a characterizing design both limiting the tram's visual impact in the urban context and improving the travel experience for passengers. State-of-the-art advanced technologies, as steering bogies, lightweight design, full Ethernet architecture, optimized climatization, driving assistance and video-analysis, make high performance possible in terms of safety and respect for the environment. In particular, the adoption of on-board energy storage system, based on advanced batteries technology, allows the tram to circulate catenary free, for the benefit of the urban architecture of city centers.

http://italy.hitachirail.com/en/tram_335.html

CASE STUDY:

A flexible and sustainable regional train platform thought for commuters

Caravaggio is the innovative, high-capacity, double-deck train platform developed by Hitachi Rail Italy and intended for regional transport. These vehicles present unique performance in terms of weight per passenger, transport capacity and consumption per passenger/km (-30% with respect to the trains currently operating in Italy) and allow great customization possibilities to meet the different operational needs of Italian Regions also furtherly improving customer experience.

http://italy.hitachirail.com/en/caravaggio_531.html

CASE STUDY:

Australia's first fully autonomous heavy haul train journey

Through the development and application of highly specialised technology based on the ETCS level 2 signalling standard, Ansaldo STS has worked with Rio Tinto to engineer and deploy a train control solution for Rio Tinto's remote iron ore rail operations in north-west Australia that will support the complete automation of the miner's rail operations. The solution includes the installation of a driving module on board each train and enables the fleet's operation to be centrally managed from a control centre many kilometres away in Perth. Such a solution delivers significant benefits to the operator including increased safety and productivity.

http://italy.hitachirail.com/en/tram_335.html

Appendix 3

Hitachi solutions for Integrated services

To deliver smart services capable to effectively impact on citizens' life in a positive way, integration is key. Data usage, analytics development and cooperative approaches can be enabled by urban control rooms as described in the present Study. Such horizontal framework enables truly smart, vertical services delivery and allow urban stakeholders to overcome the challenges of our age through digital transformation. Hitachi has already developed and deployed such solutions. Among the others, examples of concrete urban control rooms include:

CASE STUDY:

Artificial Intelligence supports Las Vegas in delivering service level that people expect from government

Exploiting the integration of a wide array of technological solution (Hitachi Smart Cameras, Hitachi Edge Gateway, Hitachi Video Analytics (HVA) for analytics, Hitachi Visualisation Suite (HVS) for visualisation, and Pentaho for data integration), Hitachi has built an "Innovation District" in downtown Las Vegas, delivering advanced, integrated and interconnected multimodal modes of transportation, physical safety, and city services.

http://social-innovation.hitachi/us/think-ahead/smart-spaces/las-vegas-iot/index.html

CASE STUDY:

A Smart, Real Time Governance Centre has been realised in a 53 million citizens' state thanks to co-creation

Hitachi has provided the Andhra Pradesh state in India with a dashboard that provides a real-time snapshot of the performance of various departments across the government. The dashboard aggregates data from more than 30 government departments (with over 300 reporting agencies, providing almost 750 services) allowing to communicate with each other. Thanks to co-creation, data related to transportation, emergency response, agriculture, energy management, and other public services and programs are analysed in an integrated manner providing a single view of truth and allowing informed decisions.

https://insights.hitachiconsulting.com/post/102enqc/under-the-hood-a-peek-into-the-real-time-governance-system

CASE STUDY:

Integration of public and private systems delivers the safest environment in Washington D.C.

Since 2009 the collaboration between Hitachi and Washington D.C. Metropolitan Police Department has provided an integrated Smart system in order to manage a critical area and deliver the safest environment to over 700.000 residents. Hitachi Visualisation Suite provided a single security interface that allowed to integrate a wide array of systems, including Computer Aided Dispatch (CAD), Records Management Systems (RMS), License Plate Recognition (LPR), Gunshot Detection, multiple video management systems, and individual cameras from private entities (1500).

https://www.hitachivantara.com/en-us/products/iot-operations-intelligence/video-analytics.html

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youtube.com/HitachiBrandChannel

Hitachi Europe Ltd.
Whitebrook Park, Lower Cookham Road, Maidenhead, Berkshire, SL6 8YA
Tel: +44 (0) 1628 585000 Fax: +44 (0) 1628 585373