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Inspire the Next

Towards the creation of Society 5.0

Hitachi's contribution to a new human-centered and sustainable society in Italy

The European House Ambrosetti

The European House
Ambrosetti

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.

Our Social Innovation Business accelerates collaborative creation with customers using the latest digital technologies in a wide range of fields, including social infrastructure. It also solves various issues faced by society and customers by taking advantage of the Hitachi Group's business bases; its total solutions, which combine the operational technology (OT), IT, products and systems it has cultivated over many years; digital solutions such as Lumada; and open innovation achieved through partnerships with operators worldwide.

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/**

The European House – Ambrosetti

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.

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Introduction

> “Society 5.0 signs a new phase of human history, a radical shift from a technology-driven to a human-centered system. This new social structure represents an ideal form of our future society, where all the people can receive high-quality services and live a comfortable, vigorous life. Society 5.0 is based on values of openness, sustainability and inclusiveness, and calls everybody on board.”

Yuko Harayama
(former Executive Member of the Council for Science and Technology Policy, Cabinet Office of Japan)

The initiative “Towards a Society 5.0 in Italy”, launched by Hitachi and The European House - Ambrosetti in 2019, aims to contribute to the debate on the evolution of the Italian society, made possible by technological innovation and digitization, highlighting the contribution that major digital players and innovative industrial actors can offer.

The purpose of this study is to analyze the possibilities and the areas of implementation of the so-called Society 5.0 in Italy - a society aimed at sustainable economic development, compatible with the resolution of the social problems and the challenges that our country is currently facing, with particular reference to the achievement of the Sustainable Development Goals (SDGs) - underlining the role that private actors and major technological players can play, and evaluating the contribution of Hitachi through its corporate commitment and the offer of highly innovative products and technologies that can support a positive transformation of Italian society.

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

- **Analysis** of databases and statistical sources to measure and assess the country's progresses towards the development of Society 5.0 and the achievement of Sustainable Development Goals as defined by the United Nations' Agenda 2030;
- **Interviews** with Hitachi's internal and external stakeholders and high-level experts (academics, business leaders and innovators) on the examined topics;
- **Case studies** and **best practices** aimed at highlighting the concrete contribution that a major player in innovation can offer in different fields;
- **Definition of guidelines and policy proposals** for the Italian public and private stakeholders, formulated in a systemic perspective, in order to promote the development and achievement of Society 5.0, maximizing the synergies and the contribution that each actor can offer to the national system.

Envisioning the society of the future means planning and implementing its development by placing citizens at the core, through the effective use of technology and the participation of all actors and stakeholders, public and private, who can play a positive role in this progress. In today's context, characterized by many paradoxes and contradictions, it is, therefore, necessary to establish a collaborative and cooperative strategy capable of effectively responding to future challenges and to the most relevant citizens and communities' needs.

The paper examines the implications, priorities and opportunities related to the diffusion of digital technologies and their support for the creation of a fully sustainable society, where companies, adopting responsible business conduct, play a key role in reducing and mitigating negative impacts on people and the environment, actively participating in the achievement of global goals such as SDGs. In this context, Hitachi solutions, case histories and technologies serve as models or best practices supporting this transition.

On the basis of the analyses and concrete results emerging from the study, the paper also summarizes different **proposals and priorities of action to relevant Italian stakeholders** involved in the creation of a Society 5.0 that takes into account the peculiarities and distinctiveness of our country, and that offers innovative solutions to solve the criticalities identified as obstacles or limits to its development.

The structure of this document is conceived as follows:

- **Chapter 1** provides a brief overview of the concept of Society 5.0, starting from the Japanese context in which it develops and examining the underlying rationale and main features;
- **Chapter 2** examines how Hitachi's vision of solving social and environmental problems and implementing an inclusive, harmonious and prosperous society through innovative solutions and forms of collaboration with its business partners and key stakeholders can contribute to the realization of Society 5.0 and to the achievement of the UN Agenda 2030 sustainable development goals;
- **Chapter 3** describes the Italian path towards the definition of a fully sustainable society and identifies the most pressing issues and challenges for the country;
- **Chapter 4** analyses Hitachi's current (and future) contribution to the creation of economic, social and environmental value in Italy, with reference to its direct presence in the country and the impact of its solutions and technologies in concrete cases, which have brought or promise real benefits for society;
- **Chapter 5** presents proposals and priorities of action to relevant Italian decision-makers and stakeholders in the construction of the so-called Society 5.0.

01 Towards a new, human-centered society: The vision behind "Society 5.0"

Introduced by the Japanese Government during the **5th Science and Technology Basic Plan**, a plan adopted in January 2016 aimed at developing innovation strategies to enhance the country's economic potential, the concept of Society 5.0 outlines an ideal vision for the society of tomorrow. It represents a step forward in human evolution guided by scientific and technological transformations, where every person can lead an active and enjoyable life, integrating cyber and physical space.

In the evolution framework drawn by the Cabinet Office of Japan, the Society 5.0 constitutes the **fifth evolutionary stage of human society**, following the hunting-gathering society, the agricultural society, the industrial society and the information society. Bringing new value to industry and society in ways not previously possible, Society 5.0 differs from the previous one by placing people security and well-being at the core of its model, becoming an inevitable evolution - in the light of the emergence of new revolutionary opportunities - and as a driver not only for Japanese but for global development.

Society 5.0 aims to create a **"Super Smart Society"**, a concept drawn by **Keidanren**, the Japan Business Federation, capable of conveying the potential of frontier technologies towards the resolution of individuals and collectivities' needs, contributing to associate the economic development with shared and positive progress. **Overcoming barriers of nationality, origin, age and gender**, the innovative solutions developed by this new society are designed to ensure a decent life for all, guaranteeing an adequate level of all those goods and services considered essential.

The concept of Society 5.0 developed in Japan in 2016 responds to the priorities defined in 2015 by the UN Agenda 2030, representing **a sustainable path to development remodeled on the basis of Japan potential and criticalities**, but highly flexible and versatile, with a distinctive approach that can balance economic progress with the resolution of social problems.

Starting from the challenges that modern society is facing, the concept of Society 5.0 identifies in the use of technology an enabler for the design and adoption of highly impactful and innovative solutions, benefitting a human-centered and sustainable development. In order to make it possible, this technological and social evolution must be developed and implemented by adopting a **cooperative approach** gathering all the potential actors of change, such as institutions, research centers, private actors and civil society, with the inclusion of the new voices that are emerging within modern societies.

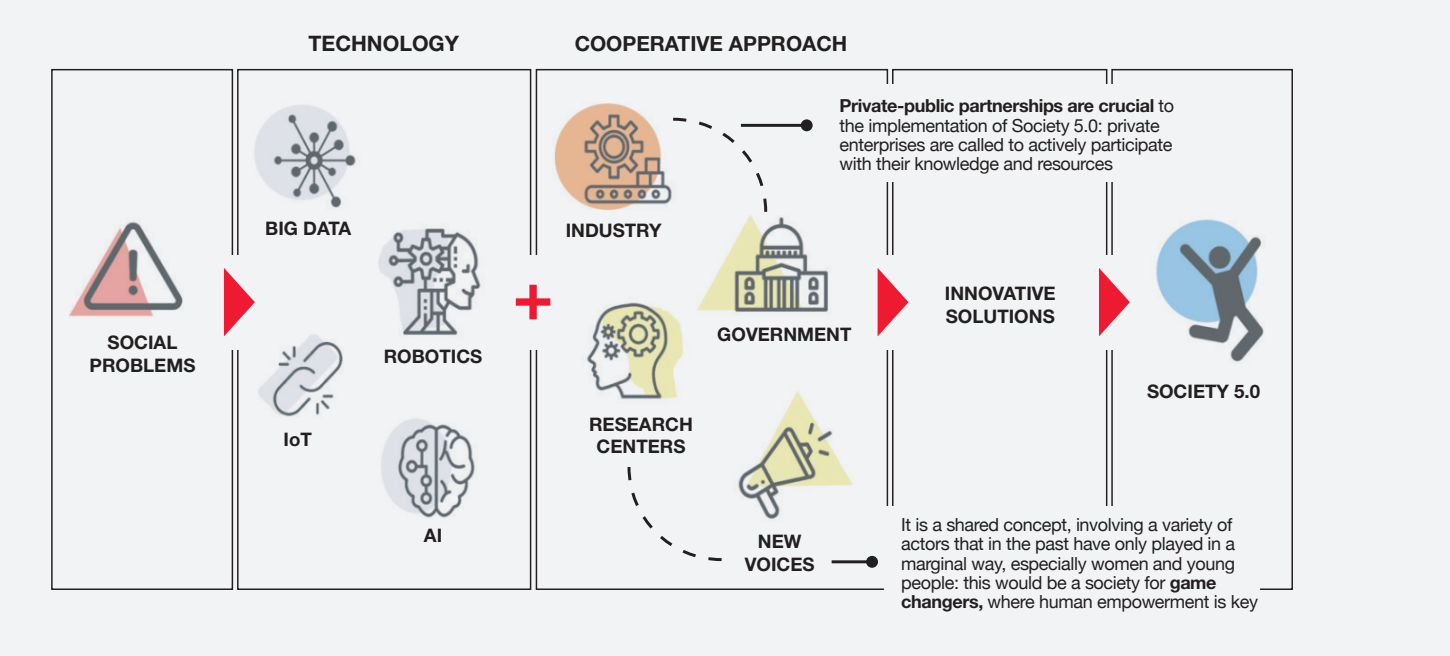

Figure 1.1: Exemplification of the model behind Society 5.0. Source: The European House – Ambrosetti elaboration on Hitachi and Keidanren data, 2019.

Figure 1.1 summarizes the **key elements and the most important features** of Society 5.0 as conceptualized by the Japanese Government. The starting point of this model is represented by the identification of relevant social problems and current and future challenges for the Japanese (and global) society. To address them, Society 5.0 proposes an approach based on a combination of frontier technologies and cooperation between all relevant stakeholders in a society. In this context, a central role is given to private actors and to technological and innovation players, who have the task of enabling the implementation of creative solutions, capable of solving social needs and responding to the identified challenges. In this way, they act as enablers of Society 5.0 at a national (or global) level.

The challenges and the criticalities faced by Japan are multiple, often interconnected, and are driving the rise of new social problems. Among these issues, the major ones are:

- The **aging society**. It depends, among other factors, on a longer life expectancy, higher in Japan than the OECD average (84.1 years, 4 years more than the OECD average), and significantly lower fertility rates (1.4 children vs. 1.7 on average in the OECD). This phenomenon determines the emergence of new needs linked to the demand for goods and services dedicated to the care of the elder population and the stress on public resources, not only for of healthcare but also for social assistance and new needs.
- The **growth of public expenditure**. It represents a second criticality closely linked to the ongoing national demographic transformation taking into account the burden of a public debt equal to 237.5% of GDP, the highest in the world.
- The need to sustain the national development strategy, in a context of **increasingly limited resources**. This triggers significant pressure on the productive and energetic models currently in force in the country. In addition, rural areas suffer from an alarming process of depopulation (half of the small Japanese rural towns are expected to disappear by 2040 [1]), a phenomenon part of a vicious circle of **growing infrastructural decay**.
- The **pollution**. Despite 2018 registering a cumulative reduction of CO_2 emissions, declining since 2013, **pollution** is a significant problem for the sustainable growth of Japan. The country suffers from an environmental issue which is typical of industrialized

1 National Institute of Population and Social Security Research (NIPSSR) data, 2019.

countries. Besides having limited natural energy sources, the country has the third world's largest manufacturing power and one of the world's highest living standards. The current production system is responsible for the generation of large quantities of gas emissions into the atmosphere, which, with its accumulation, contribute to the greenhouse effect. Pollution is also intensified by the high concentration of citizens in urban areas.

- The presence of **social inequality**. It limits not only the achievement of good standards of quality of life of people but also the possibilities of economic development, hindering dynamics of social mobility and meritocratic mechanisms. Japan reports an average disposable income per capita (equal to 29,798 US dollars per year) which is lower than the OECD average, and a significant gap between the wealthiest and poorest segments of the population: the richest 20% earns six times as much as the poorest 20%. [2]

- **International competition is becoming increasingly severe**. Countries such as China have embarked on major investment plans (Chinese spending on R&D has increased at a yearly rate of 18% between 2010 and 2015), while economic forecasts estimate that Japan will have **little prospective growth**. According to the International Monetary Fund, real GDP growth between 2019 and 2022 is expected to be 0.5% per annum, well below the United States (1.8%) and the EU average (1.9%).

To solve the aforementioned problems, the distinctive approach proposed by Society 5.0 consists of the combination of two fundamental pillars: the use of **technology** and the **cooperative approach**.

Considering the role of technology, Society 5.0 seeks to convey the enormous potential expressed by innovation towards the resolution of the most significant problems for society. From this point of view, technologies such as IoT, Artificial Intelligence (AI), Robotics and Big Data, all areas in which Japan and its industry represent global excellences, become a key tool for improving the quality of life:

- **Big Data** can be defined as the set of vast amounts of digital data. Thanks to an increase in sources and tools able to generate them, their availability is growing exponentially. If on one side the growth of their volume already poses challenges in terms of storage, security and use, on the other one their availability will offer greater value in terms of competitive advantage and the possibility of creating value-added products and services, revolutionizing production processes and organizational and service models. For this to be possible, it is necessary to have the adequate abilities to process and gain value from them through appropriate infrastructures, Data Analytics and skills.

- **IoT (Internet of Things)**. In a context characterized by an increasing accessibility to fast connections and growing availability of data, the **Internet of Things** allows to maximize the collection and use of Big Data from a multitude of sources (industrial products, factory systems, transport vehicles ...) to the benefit of greater digitization and automation of processes, also linked to machine learning technologies and Artificial Intelligence. For example, the application of specific sensors to everyday objects - from mobile phones to light bulbs - generates data that can be aggregated and analyzed. It makes elements of society that were previously only intuitable now intelligible from an analytical point of view, enabling unprecedented solutions.

- **Artificial Intelligence** consists in the ability - through software and algorithms capable of performing actions

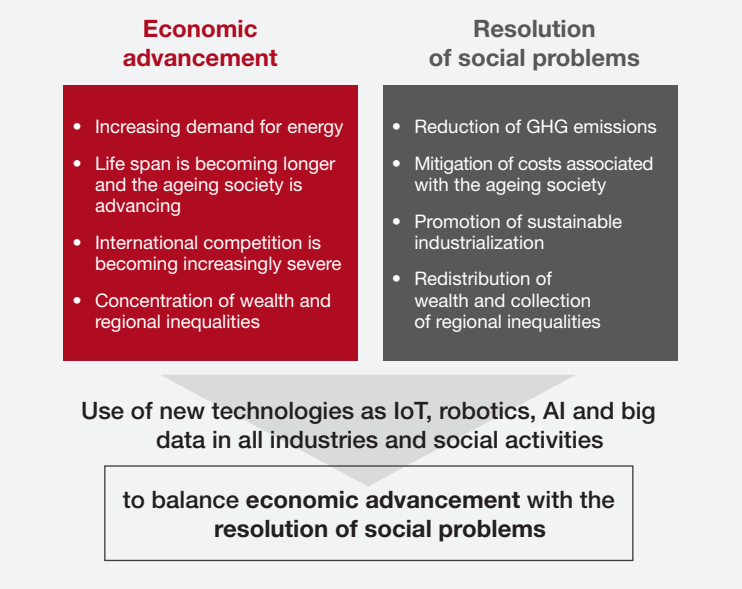

Figure 1.2: The Society 5.0 model.
Source: The European House – Ambrosetti elaboration on Hitachi data, 2019.

2 OECD data, 2019.

typical of "human intelligence" with different degrees of autonomy - to analyze the operating environment and process the information collected or available, obtaining decisions aimed at achieving a goal or a result. This category already includes numerous solutions and situations, with varying degrees of complexity, e.g. automatic translators, predictive diagnostics software, autonomous driving, even the most recent solutions for the recognition of human feelings and emotions.

- **Robotics and automation**. Closely linked to progress in the three previous areas, automation is already revolutionizing multiple economic and service sectors. While automation poses major challenges in terms of skills, training and the risk of drastic workplace changes, it also promises to improve the quality of life of individuals by exempting them from performing principally routine, tiring or risky tasks.

Secondly, the involvement of all the actors and the stakeholders of the society, through the so-called cooperative approach, is a fundamental prerequisite to allow these technologies to create a Society 5.0, triggering that progress having a genuinely positive impact on society. The use of digital technologies to identify innovative solutions is part of this approach, in which **creativity** and **imagination** are key elements for the implementation of a society that embraces diversity and puts the welfare of people at the core.

In particular, a central role is played by the private sector, the **business community**, the **enterprises** and the **innovative actors**. All companies, of any size and sector, are called upon to provide a meaningful contribution through the development of new responsible business models, targeted investments and multistakeholder partnerships. The innovation represents a key element for effective business contribution. Indeed, companies are looking for a combination of innovation (product, service or process) and sustainability that can generate a **dual benefit:** giving shape to the Society 5.0 and at the same time benefitting companies' competitiveness, **combining economic growth and sustainable growth.**

The opportunities for enterprises are significant: the turnover resulting from the development of sustainable business models worldwide has been estimated at USD 12 trillion, an economic value that can lead to the employment in sustainable entrepreneurial forms of more than 380 million people by 2030.[3]

Within this approach, collaboration between local government and businesses, through forms of **public-private partnership (PPP),** is one of the most important tools to implement effective measures for local and sustainable development, as systems capable of strengthening trust between the different actors based on the construction of a common metric and a shared goal to be achieved.

In the light of the role assigned by Society 5.0 to innovation and new technologies, actors of innovation and developers of platforms and technology solutions play a starring role among private companies. In the Japanese entrepreneurial fabric, many **companies excel in new technologies.** With over $134 billion in 2017, Japan was the second-largest country in the world in terms of business R&D spending (EBRD) [4], and Japanese manufacturers provide 52% of the actual global supply of industrial robots.[5]

Together with the private sector, **research centers**, which form the backbone of the Japanese innovation ecosystem, play a significant role. With 75,593 academic citations in 2018, Japan is the sixth country in the world in terms of research quality [6], among the top five for total R&D spending (3.2% of GDP) [7], as well as the second country in the world for the number of researchers per million inhabitants.

Finally, Society 5.0 adopts a highly inclusive approach that requires the participation of the whole community in the definition of the most pressing social problems and above all in the creation of shared and accepted solutions. For this reason, the Society 5.0 aims to activate sections of the population previously scarcely involved or categories of citizens formerly marginalized, such as **women** and **new generations**. Indeed, Japan, the last country of the G7 after Italy in terms of women active in the labor market compared to men, presents great room for improvement and still largely underutilized potential.

As mentioned above, with the objective of resolving social problems, **Society 5.0 contributes to the implementation of the UN SDGs** and represents **Japan's strategy** in supporting this global initiative.

3 Business & Sustainable Development Commission, 2017.
4 OECD data, 2017.
5 International Federation of Robotics data, 2017.
6 SCIMAGO data, 2019.
7 OECD data, 2017.

Sustainable Development Goals (SDGs)

In September 2015, the United Nations General Assembly adopted the 17 Sustainable Development Goals (SDGs) with the resolution to "Transform Our World: Agenda 2030 for Sustainable Development" and a promise to leave no one behind. The 17 targets gather 169 sub-targets covering all dimensions of human and natural life, to be achieved by all countries in the world by 2030.

The 17 Sustainable Development Goals represent a global call to action to all, governments, institutions, NGOs, businesses and civil society, in order to contribute to the effort to put the world on the right track towards sustainability: for this reason, the Agenda 2030 requires open and participatory decision-making and implementation processes. The goals synthesize a strong demand, still largely unfulfilled, towards the creation of a sustainable future on a global scale.

Keidanren has identified nine different sectors in which Society 5.0 can be applied to help achieve the SDG's, contributing both to the creation of the necessary conditions for the realization of many of them, and to offer an innovative resolution through digital solutions. These are often interdependent areas, such as the prevention of environmental and climate disasters, the development of cities and regions and the energy sector, which together cover all UN objectives.

- **Cities and regions:** The development of sustainable and resilient urban realities involves several SDGs, including the efficient management of the water system, energy consumption and more generally the establishment of consumption patterns capable of ensuring sustainable use of limited resources. Society 5.0, also in light of a global percentage of urbanization expected to rise to 68% in 2050 [8], offers a valuable contribution through the implementation of systems focused on data control and monitoring, ensuring increasingly effective and timely services to citizens.

- **Energy:** the availability of safe and clean natural sources is key to the optimization of energetic flows and to ensure a more reliable and sustainable world for future generations. Current technologies provide a valuable contribution that can significantly impact on the demand for energy, on its transmission (limiting its dispersion) and on the effectiveness of its use, allowing energy to get exactly where it is needed when it is needed, with maximum efficiency and with the least negative environmental, economic and social impact.

- **Disaster prevention:** the intensification and increased frequency of extreme natural events – in 2018 alone 289 natural disasters affected 61.7 million people, of which more than 10,000 died [9] - requires the rapid identification and implementation of solutions to mitigate ongoing climate change. Society 5.0 can contribute to mitigating these impacts and minimizing the risks related to the safety of individuals and their property, especially in areas subject to high vulnerability to natural disasters. This can be done through the prevention and monitoring of infrastructure, guaranteeing prompt maintenance and timely restoration in case of service disruptions.

- **Healthcare:** the health sector, put under pressure from the conjunction of increasingly pressing challenges of an ageing population and a growing constraint on public spending, requires a comprehensive rethinking in order to guarantee smart and accessible care to everyone. The combination of digital technologies, IoT and advanced data analysis leads to an innovative generation of valuable and costeffective healthcare services. The application of virtual reality and augmented reality to the health sector, a global market worth €780 million and expected to weigh €4.6 billion in 2025 [10], can improve, among other things, laboratory design, technical assistance and training.

- **Agriculture and food:** the implementation of co-design new technologies enable a growth based on knowledge-based competitiveness, environmentally sustainable and inclusive, fostering employment and social cohesion.

8 World Urbanization Prospects data, 2018.

9 Data from the United Nations Disaster Risk Reduction Agency (UNISDR) and the Disaster Epidemiology Research Centre (CREC), 2019.

10 Data from Zion Market Research, 2019.

The innovative solutions apply to every stage of the agricultural supply chain, from production to food distribution and processing, for example, through the use of Big Data and IoT technologies. The so-called Precision Farming solutions can reduce the stress on natural resources, maximize productivity and avoid waste.

- **Logistics:** by ensuring a regular and smooth flow of goods and services, logistics plays an essential role in economic growth, constituting the infrastructure that supports the performance of all business activities and daily activities. Cutting-edge technological solutions improve real-time logistical monitoring and control, also thanks to accurate demand forecasts and, thanks to AI, service provision increasingly finely tailored to the diverse individual and latent needs.

- **Manufacturing and services:** from design and development to logistics, industrial processes need to be fair, responsible and sustainable. Current technologies allow the adoption of organizational models capable of maximizing efficiency, sustainability (also in terms of circularity) and productivity, to make sustainable and safer products available and to increase companies' competitiveness.

- **Finance:** to improve decision-making effectiveness and guarantee a better user experience, organizations need to accelerate the digital transformation and make the most of the data available. Forecasts deriving from the synergy of IoT, machine learning and artificial intelligence allows the creation of personalized services, enable more informed decisions and mitigate risks. The use of these technologies, as well as of crypto-currency and blockchain systems, is aimed at simplifying payments and achieving a higher level of transparency and security.

- **Public services:** A rethinking of central and local public systems centered on digitization, on the use of shared data and service integration will permit a timely and increasingly adequate response to citizens' needs. The purpose of Society 5.0 is to facilitate the exchange of information between the national and regional entities, decentralizing and encouraging the generation of new creative solutions to optimize the different processes by constantly adjusting and calibrating them on the new community needs.

In the Society 5.0 distinctive approach, decentralization and diversity are encouraged, while innovations are always oriented towards the creation of shared value, in harmony with the environment and in respect of the community.

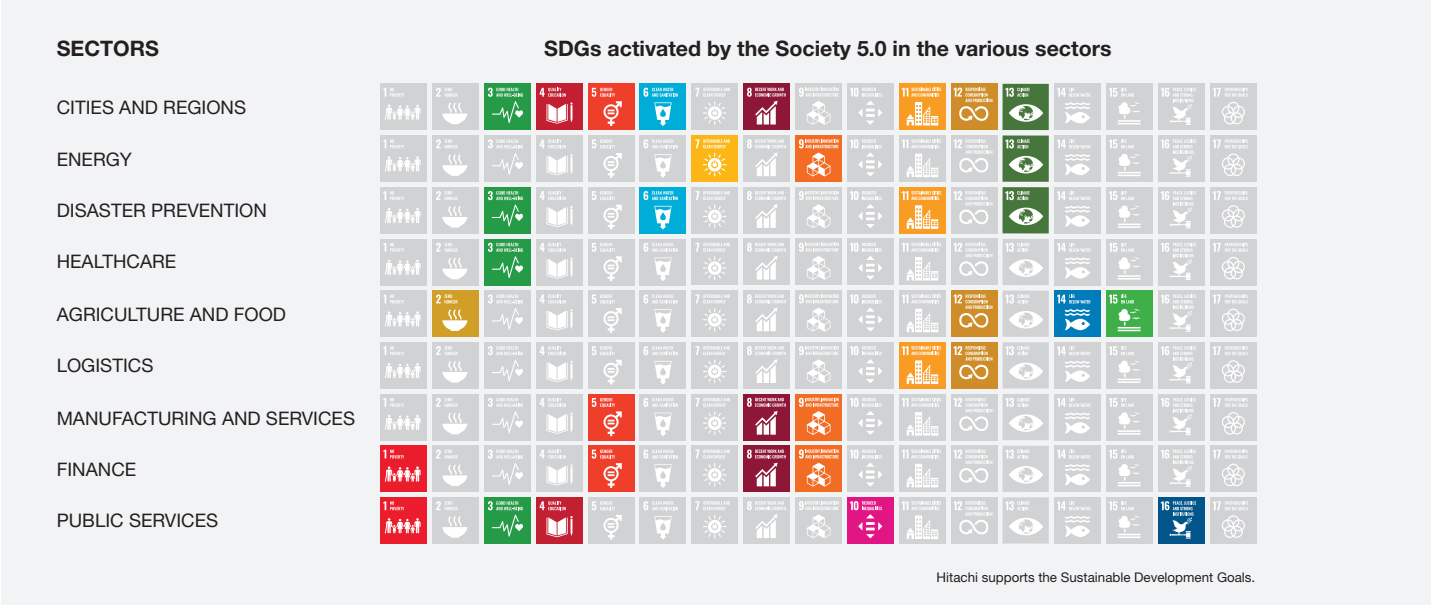

Figure 1.3: SDGs activated by Society 5.0 in the different sectors identified by Keidanren.
Source: The European House – Ambrosetti elaboration on United Nations data, 2019.

The Society 5.0 implementation strategy guides Japan towards SDGs achievement. However, this model is not designed to be applied only to Japan but can be extended globally, within other nations, with the same benefits, to solve specific social problems and contribute to the construction of a more sustainable society.

In this context, and with this perspective, Japan and its multinationals represent key drivers to promote the export and the implementation of Society 5.0 abroad, facilitating its replicability especially in those countries that share problems and characteristics similar to those of Japan. In this sense, Japan can be considered a successful pilot platform, leader in digital transformation, with its industries providing an example and the trigger for the launch of a society in which people with different backgrounds can actively participate and, together with innovation, science and technology, contribute to a more sustainable development. In this perspective, Japanese multinationals become potential ambassadors and exporters of the Japanese model, stimulating an active contribution of all actors, in line with the vision and the objectives summarized by the UN SDGs.

Hitachi Social Innovation Forum 2019 EUROPE

Gathering over 400 leaders from all over Europe, Hitachi's first pan-European forum entitled "Human-Centric Digital Transformation" took place on November 7th in Milan. The event is part of a wider program of conferences, business sessions, seminars and exhibitions through which Hitachi shares its vision with customers around the world.

HSIF 2019 represented a unique opportunity for discussion and sharing ideas around Social Innovation, providing companies with the opportunity to develop a vision for collaborative creation and to apply the latest technologies to solving society's challenges, from which both entrepreneurship and tomorrow's society can benefit.

During the event, Yuko Harayama – former Executive Member of the Council for Science and Technology Policy of the Cabinet Office of Japan, considered one of the creators of Society 5.0 – explained the vision behind this concept and how it has been embraced in Japan and around the world.

In the last decades, the world has been undergoing a substantial transformation with innovation as a driving force. By using the digital transformation as an enabler, Society 5.0 aims to the achievement of economic growth and well-being. According to Harayama, in fact, Society 5.0 can address the various societal challenges deriving from an increased social complexity and an aging population, contributing to the global prosperity and to the realization of the UN Sustainable Development Goals.

Society 5.0 goes beyond technological challenges: in order to unlock the whole human potential, it is necessary to build a new mindset capable to challenge the existing norms and explore new synergies, promoting the cultivation of empathy and sharing the values of inclusiveness, diversity and openness.

As the work Hitachi is developing with its business partners demonstrates, the collaboration and co-creation among different stakeholders are key to reconcile social and corporate benefits, with Society 5.0 becoming a fundamental tool to frame business actions.

02 Hitachi's vision to contribute to Society 5.0 globally

In the use of digital transformation to solve the most pressing social problems and the challenges of the present and the future, and within a cooperative approach that brings together private actors, institutions and civil society - as conceptualized by the Society 5.0 model – the enterprises are the driving force behind the process. The involvement of companies is, in fact, an integral part of the model, of which they are protagonists by adopting a proactive approach.

In this context, **Hitachi is a privileged player** in the development and implementation of the Society 5.0, becoming a leading protagonist in the Japanese sustainable transition. Hitachi's **corporate Mission**, which has been at the heart of its work since its founding in 1910, is **entirely in line with that of Society 5.0**. Hitachi, indeed, aims to develop a human-centric society through the implementation of cutting-edge technological solutions that, with an approach focused on co-creation, meet the real needs of the population. Hitachi was founded under the guidance of Namihei Odaira with the far-sighted vision of "Contributing to society through the development of superior, original technology and products", a Mission that today unites more than 300,000 employees worldwide.

Since the beginning of its history, through the manufacture of products developed using its technologies, Hitachi has been a **promoter of sustainable innovation**, offering solutions to the different economic, social and environmental problems that the society had to face from time to time. Today, thanks to the definition of an Operational Technology (OT) capable of streamlining production processes and the development of large-scale Information Technology (IT) systems able to support its infrastructures, Hitachi has become a universally recognized leader for the quality and the reliability of its products and services, and a global forerunner in terms of providing technological solutions able to answer to the needs of individuals and the society.

Besides, developing cutting-edge technological solutions, Hitachi contributes to the technological pillar of Society 5.0. Indeed, in a framework where the evolution of technology through IoT and AI is progressively transforming companies and people's lives, Hitachi has chosen to use its expertise and distinctiveness to serve its customers and the society as a whole.

Thanks to this approach, Hitachi is able to develop solutions in different fields, from robotics - where Hitachi has been a pioneer, in 1963, with the launch of the first robot used to remotely control the activities of a nuclear power plant [11] - to the implementation of Hitachi AI Technology/H (known as "H"), announced in 2015 as the first general purpose AI available on the market. [12]

11 The history of Hitachi Group robotics dates back to 1960, when the so-called servo manipulator was launched.

12 Hitachi Review, Vol. 65, No. 6, "Achieving General-Purpose AI that can learn and make decisions for itself", 2016.

Lumada

In offering effective and efficient solutions to its customers' problems, Hitachi is continuously committed to upgrading its products and improving their performance in terms of consumption and speed of service. Today, however, several factors increase the difficulty of identifying critical issues. This is due to the presence of different lifecycles and layoffs, along with the emergence of an ever-increasing demand for customization of the service.

Lumada, developed by Hitachi in 2016, consists of a core of platform services, architecture and technologies that enable value creation from customers and accelerate the development of digital solutions. It represents an open, shared and highly flexible system, integrating Machine Learning and Artificial Intelligence to turn data into insights driving digital innovation throughout Hitachi's advanced solutions and services.

After sharing and establishing, jointly with the customer, a business model that includes the objectives and the vision to be adopted, Lumada collects the data generated by the IT and the OT, transforming them into key actionable insights for the creation of more effective digital solutions to solve the problems previously identified. It is a process whose application is not limited to industry, but which lends itself to a variety of sectors, such as mobility, energy, power and the health sector.

Hitachi also adopts a cooperative approach based on the logic of co-creation, an element which, as stated above, is both an integral part of the creation of Society 5.0 and at the basis of Hitachi's operating model. Co-creation reaches a variety of sectors and supply chains, creating shared value at each step along the value chain.

In the corporate context and in the relationship with its customers, the cooperative approach is expressed through the implementation of co-creation models that provide a first phase in which the methodology adopted is shared and then the construction of highly customized solutions, able to respond optimally to the challenge that the customer faces. Bringing stakeholders directly into the innovation process means that in an increasingly complex world, companies are developing new innovative products and services in a more efficient way.

In the field of energy audits, the approach based on the H-Vision model goes beyond the mere production of data collected by specialists. H-Vision aims to develop an intelligent analysis able to provide specific solutions that take into account the root causes of waste and the inefficiencies in the production cycles, establishing circular economy principles.

Thanks to these characteristics, Hitachi is able to offer an essential contribution to develop Society 5.0 and "Companies 5.0".

Scope	Priorities of Society 5.0	Hitachi's commitment
Healthcare, medical, nursing care	The current health systems are facing a complex scenario, characterized by major demographic, epidemiological and socio-economic changes, with critical issues to be managed. As an example, the population is progressively ageing and chronic diseases are increasing. Society 5.0 aims to improve people's health, life expectancy and QoL.	Hitachi improves its diagnostic imaging services by exploiting the potential of Artificial Intelligence and develops community-based platforms for a more effective and articulated care service, able to collect and manage simultaneously both large historical datasets and information collected in real-time.
Mobility	Smooth and safe mobility can guarantee accessibility to a wider range of users and a high-quality service, with limited impacts on the territory and able to allow better users' experience, punctuality and safety.	Hitachi works to ensure high-quality management of railway operations, aimed at offering increasingly reliable and safe services. Hitachi also proposes last-mile traffic solutions.
Production	An industry with more efficient production processes and better environmental management systems can significantly reduce its production of pollution and waste, and its consumption of water and other resources. Efficiency also has positive consequences for businesses, reducing operating costs and dependence on raw materials.	Hitachi develops work support systems, in which data measurement and analysis are used to enhance workers' skills and increase the quality of the work environment. Additionally, Hitachi's technology is applied to streamline the supervision process and optimize the operations of the manufacturing plants.
Infrastructure, Urban development	Infrastructure plays a key role in the achievement of individual and collective goals. This is particularly true in urban centers, which can become laboratories of technological innovation and sustainable development through the design of safe and resilient infrastructure and services.	Within this framework, the Group is constantly engaged in the implementation of new integrated security solutions, such as the analysis from surveillance camera, recordings through AI, and the improvement of the efficiency of maintenance services for the forecast of infrastructure failures. These services are enabled by the development of precision sensors such as those usable for buildings, roads, etc.
Finance	Simplifying and securing financial transactions contributes to the growth and development of the economy, but also to the stability and economic independence of individuals. Increasing the convenience and the simplicity of payments means favoring trade, even of small and medium enterprises.	To facilitate and simplify payments, Hitachi uses fingerprint identification systems, biometric payment services, cash-less and card-less solutions. The Group also develops supply chains based on blockchain technology.

The Group's particular attention to sustainability and the creation of a fair and inclusive society, capable of responding to the needs of communities and individuals, is also evident considering the strategies and governance of the Group. In the fiscal year 2017, Hitachi set up an Executive Sustainability Committee in order to accelerate the company's commitment to achieving the SDGs established by the United Nations. Chaired by Hitachi's President and CEO, Toshiaki Higashihara, the Committee identified the 11 SDGs that represent the most important social challenges for the Group [13] and in which Hitachi can play a key role from a dual perspective:

- The challenges on which it can act with its business strategy, technological solutions and product;
- The areas it affects through the commitment of its entire corporate structure. The latter represent the areas of cross-cutting interest to all areas of Hitachi's business and management. Therefore, they represent the Group's broadest commitment to the company.

Hitachi has internalized these priorities through a structured methodology, which connects the achievement of the SDGs goals to the implementation of concrete and measurable solutions. The idea of being able to contribute significantly through a wide range of business solutions was welcomed with conviction by the company. Even in this case, the effective implementation of the plan in Japan passes through an approach strongly oriented to cooperation, in a continuous and constructive dialogue with the Universities of Tokyo, Kyoto and Hokkaido in the field of Open Innovation. Numerous projects and concrete business cases, also in light of the variety of its operating sectors, demonstrate the wide contribution that Hitachi can offer to the achievement of SDGs, not only in Japan but also in the different countries in which it operates.

Starting from the SDGs on which Hitachi can influence with its business strategy, some concrete solutions implemented by the Group are highlighted, as an example, on the following page.

Figure 2.1: SDGs identified as priorities for Hitachi's business strategy.
Source: The European House - Ambrosetti elaboration on Hitachi data, 2019.

13 Hitachi recognizes the interaction and interdependency between all SDGs and remains committed to the realization of all 17 goals both directly and indirectly.

CASE STUDY	SDG IMPACTED
Habitat Innovation is a joint project between Hitachi and the University of Tokyo Joint Research Laboratory (H-UTokyoLab) that aims to achieve Society 5.0 in terms of issues relevant to city residents. By exceeding the conventional boundaries of organizations, the initiative seeks to realize a sustainable urban development in which industry, academia, government and citizens team up to promote new comfortable and vital ways of life.	
Hitachi has developed a **desalination system** that uses seawater and purified wastewater. In this process, through Artificial Intelligence, it has been possible to achieve a 30% reduction in energy consumption vis-à-vis normal factories. Thanks to this technology, Hitachi can help to solve the increasingly pressing lack of water due to the global population increase and an increasingly high standard of living.	
In Japan, Hitachi has applied **digital technology** solutions to **wind turbines in order to** adapt them to a territory with different peculiarities. This project responds to the critical issues of a hostile geographical environment, the lack of plain and a more general lack of space. In addition, through the collection of IT data, this technology also supports more stable operations and more efficient and faster maintenance service.	
Hitachi System Micro Clinic works with AU Finance [14] to increase access to financial services for the population living in rural areas of India. Through the **Financial Inclusion for Everyone**, Hitachi has provided the necessary support in terms of Internet connection, printers, laptops and banking software.	
Through the **Intercity Express Programme (IEP)**, Hitachi has developed 866 new vehicles for the rail transport in the UK, a fleet that sets a new standard in terms of capacity, reliability and asset durability. These are vehicles with a limited environmental impact, which offer, in terms of social gain, a reduction in the overall duration of the travel time and improving the possibility to travel easily between the various cities in the country.	

These are only a few examples or limited cases which demonstrate how Hitachi is committed to the realization of the SDGs. However, it is important to underline how all the solutions and the products of Hitachi are designed with a **Social Innovation** perspective. This means that the technologies designed by Hitachi are not an end in itself, but are used to promote the improvement of people's lives actively: Social Innovation implies conveying innovation towards the community's well-being, favoring a convergence of technologies, industries and business models. Just like Society 5.0, this concept aims to achieve the Sustainable Development Goals. For this reason, it requires companies and society as a whole to work together with the aim of improving the people's quality of life.

Through its **Social Innovation**, whose objective is represented by the phrase "Hitachi Social Innovation is POWERING GOOD", the Group generates value for a variety of stakeholders through:

- Positive change for the communities, with users and citizens more responsible, involved and interested;
- Accelerated progress for governments, under increasing pressure for sustainable growth;
- An increase in the efficiency and sustainability of companies, taking into account long-term business performance indicators.

14 AU Small Finance Bank is an Indian commercial banking institution.

Hitachi approaches the theme of sustainability distinguishing the impacts in three different areas, strongly interconnected and characterized by complex cause-effect relationships: these areas are **economic, social and environmental**. Hitachi aims to generate value that goes beyond the economic and this has to be social value - which can be identified in the resolution of the community's needs - and environmental value – recognizable, for example, in the reduction of polluting emissions.

In conclusion, the Group's commitment to contribute to Society 5.0 and to achieve the SDGs is not limited to a short-term approach with current actions and initiatives. Indeed, Hitachi has a **long-term perspective**, which is divided into two phases.

- The new 2021 Mid-term Management Plan defines a new ambition for Hitachi, which shifts from the realization of a corporate vision oriented to the construction of a "global company" to the perspective of becoming a "global leader", able to be a source of inspiration in terms of social innovation worldwide, to improve people's quality of life and to increase the value generated for its customers and partners.
- In 2018, Hitachi published a new report, "Onward to 2030 - Hitachi's Road to Sustainability", which defines the long-term vision and the strategy of the Group, and aligns Hitachi's term with the one chosen by the United Nations Agenda.

These elements, together with the Group's global presence, enable Hitachi to be the ideal candidate for exporting, through its corporate ethos, the model of the Society 5.0 outside Japan. This can be accomplished especially in those countries which share similar social issues and an analogous commitment to an integrated approach to sustainability. The Group, therefore, is a **contributor of global importance**, able to trigger and lead the achievement of the Sustainable Development Goals on a global scale, starting from those countries in which it operates while maintaining the distinctiveness and the commitment presented in the current chapter.

03 Italy and sustainable society: goals, progress and critical issues

The model of the Society 5.0 described so far is a **paradigm potentially exportable** outside Japan and applicable in other countries, to promote the achievement of social goals to successfully address the most important challenges of modernity. This is particularly true for those countries endowed with a particularly receptive ecosystem of innovation (companies, universities, research centers, talents, ...). Here it is possible to leverage on the role of the multinationals that have embraced the Society 5.0 model and can, therefore, act as a driving force for sustainable, human-centered development.

In particular, the Society 5.0 model and the vision underlying it - oriented towards the creation of a sustainable society that passes through the understanding of social and environmental expectations with a focus on technological development - can find a **particularly favorable context of application** in Italy, a country that shares with Japan many social problems and needs, challenges and endowment in terms of skills and know-how.

Although they are two countries geographically and culturally far apart, considering the actual **socio-economic framework** Italy and Japan appear to be similar, with respect to the other developed economies. [15]

The social problems shared are multiple. First of all, they are the **"oldest" countries in the world**, considering the average age of the population: Italy is the second oldest country in the world after Japan, with an estimated 168.7 elderly people for every 100 young people. [16] Japan, with 27.5% of the population over 65, is the oldest country in the G7. With 23.3%, Italy ranks second and is 3.2 percentage points behind the European Union average. It is expected that this gap will become even more marked in the future: by 2050, the average age of the Japanese population will be 54.7 years (48.4 in 2020), the Italian one 53.6 (47.3 in 2020). [17]

Both countries suffer from a rapid and consolidated demographic decline: between 2019 and 2029 the total Japanese population, from 126,860 thousand, will decrease to 121,441 thousand, while from the current 60,550 thousand Italy will move to 59,208 thousand inhabitants.

These trends, together with other factors, generate drastic changes in the society structure, determining the rise of social needs and causing unprecedented stress on major cost centers of public spending (health care, pension system, ...). The percentage of Italian public spending on the old-age care is now the highest among the G7 countries (13.6%), 6.6 percentage points higher than the OECD average.

These figures are particularly significant given the size of the public debt of the two countries. With a value of 237.5% of its GDP, Japan is the country with the highest public debt in the world. Considering the developed countries, Italy ranks third with 133.4% of GDP.

15 Considering the member countries of the OECD.
16 World Bank, "World Bank Population estimates and projections", 2019.
17 UNCTADstat data, 2019.

In terms of economic growth, Japan and Italy share a lower performance than other advanced economies. Considering the estimates of the International Monetary Fund, between 2019 and 2022 Japanese GDP will grow on average by 0.5% per year, Italian GDP by 0.7%. The United States will record a more than double economic growth, equal to an average of 1.8% per year. The same applies to the European Union: +1.9%.

Finally, Italy and Japan, with respectively 42.2% and 43.6% of the total, are also the G7 countries with the two lowest rates of female participation in the labor market. The difference between the worst country (Italy) and the best (Canada) exceeds five percentage points. Despite these weaknesses, Italy and Japan distinguish themselves from the other developed countries by a series of common strengths that represent the **ideal elements** for the introduction of the Society 5.0.

Both are characterized by the presence of a **dense network of skills and knowledge** spread throughout the territory, a know-how that reflects in the quality and number of scientific publications and patents, as well as in terms of a recognized excellence in robotics.

In 2017, Japan was the fourth country in the world in absolute terms of number of international **patent applications**, while Italy was eighth [18]. Italy and Japan are also in the world top ten in terms of number of **journals and scientific publications**: Italy is the first country in the world for scientific publications in the last 20 years, Japan 9th.

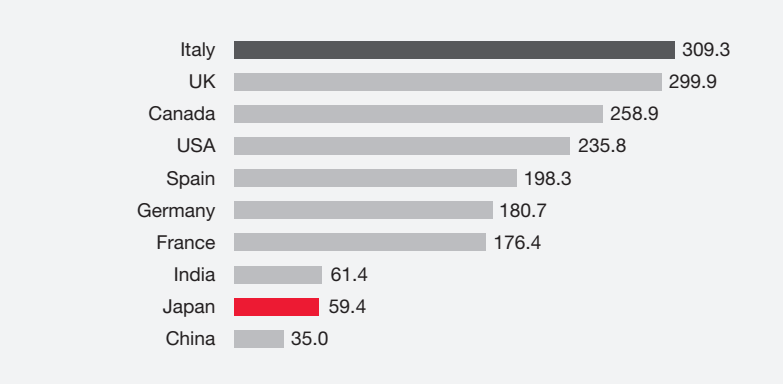

Figure 3.1: Number of citations per researcher (absolute value in the world's top-10 for publications), 1996-2017. Source: The European House - Ambrosetti elaboration on Scimago and OECD data, 2019.

From an industrial point of view, both countries excel in manufacturing and in the hi-tech sector. Japan and Italy are also among the top 5 countries in the world in terms of value of the manufacturing trade balance.

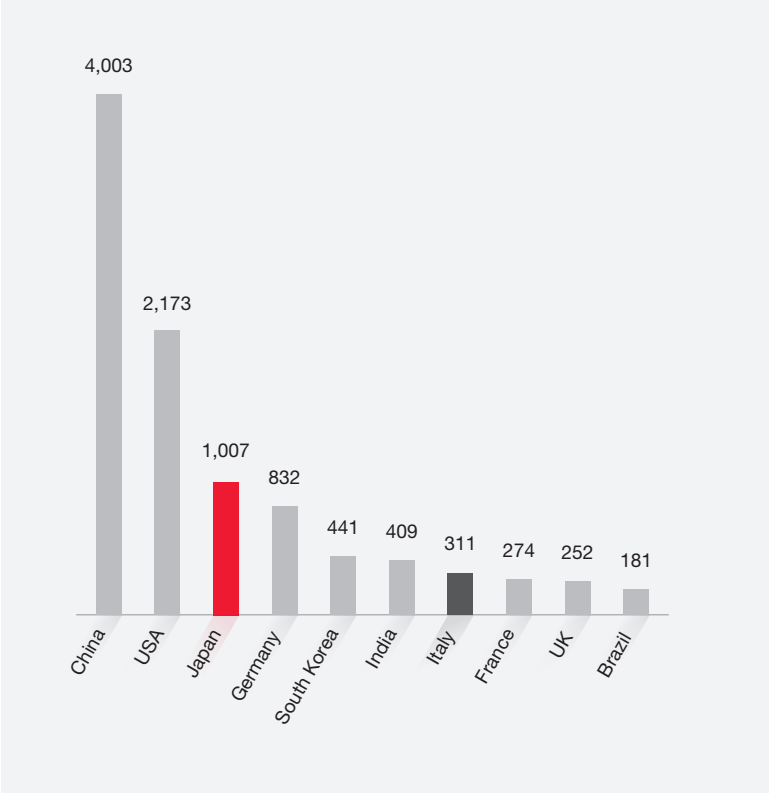

Figure 3.2: Top-10 countries by manufacturing value added (values in $bn current), 2018. Source: The European House - Ambrosetti elaboration on World Bank data, 2019.

Both countries are forerunners in the **field of robotics**: with almost 25 units per 10,000 inhabitants, Japan is the second largest intensive user of robots in the world, just after Korea, which has 35 units per 10,000 people. In terms of robot intensity Italy ranks 10th, with about 8 robots for every 10,000 inhabitants, a sector that is growing by 19%: better than countries like the United States, France and Finland. Considering the number of robots installed, in 2016 Japan ranked 4th with 303 units, while Italy was in eighth position with 185 units. [19]

Finally, considering its commitment to sustainability, Italy has always been at the forefront of many **formal commitments and concrete actions** taken by governments, but also by businesses and civil society players to achieve, by 2030, the 17 sustainable development objectives defined by the United Nations. [20]

18 WIOD, "World Intellectual Property Indicators, Ranking of total (resident and abroad) IP filing activity by origin", 2018.
19 International Federation of Robotics e OECD, 2019.
20 The UN Agenda 2030 of September 2015 was implemented in Italy by law 221/2015.

Like Japan, Italy has demonstrated a concrete and constant commitment to reaching its targets, starting with the definition in 2013 of the **Equitable and Well-being Indicators** [21], which have become part of the national economic planning process three years later, as well as a leading player in the process of building, signing and launching the Agenda.

The design of the Italian **National Strategy for Sustainable Development** defines, with a three-year update, the reference framework for the environmental and territorial planning, programming and evaluation processes, besides representing a coordination tool for the implementation of the Agenda in the country. Particularly receptive to the theme of sustainable growth, Italy has made sustainability a strategic priority for national development, introducing in 2018 a national commission for sustainable development, oriented to the harmonization of the various initiatives.

Several factors in common between Japan and Italy encourage the effective adoption of a model corresponding to the Japanese concept of Society 5.0. Such a model would find fertile ground in Italy and would support the country in tackling the various existing social criticalities. Despite the efforts of planning and coordination, today, in fact, the general picture that emerges from the analysis of objectives, progress and criticalities of the country shows a path towards sustainability characterized by lights and shadows.

Data released by ISTAT on June 26, 2018 portrays a country where more than **5 million people** cannot afford to satisfy basic needs: the number of people trapped in a situation of "absolute poverty" has never been that high since 2005, despite the phase of economic recovery entered by the country. Despite recent years' progress, Italy still needs a **radical rethinking of its development model** to achieve a significant reduction in the distortions that threaten the quality of life of citizens, such as poverty, inequality and environmental degradation.

In order to be effective, this transformation must originate from the participation of all public and private actors capable to offer a concrete contribution, according to an inclusive and collaborative approach. Considering the private actors, central to Society 5.0 creation, there is a progressive **responsibility assumption by Italian companies**, partly linked to the far-sighted recognition of the interconnection between long-term profitability and the socio-economic-environmental context in which they are located. The competitiveness of a company depends on the surrounding environment and the community in which it is located, and at the same time the well-being of a society depends on the possibility of having competitive companies in its territory that can create wealth and quality employment.

This generates a long-term synergy between economic and social objectives, from which both enterprises competitiveness and social conditions can benefit.

Sustainability can therefore become a factor of competitive advantage for Italian companies: from an analysis comparing the productivity bonus for sustainable manufacturing companies to non-sustainable ones, for the period 2015-2017, it is possible to highlight a positive (and incremental) correlation between the level of sustainability of a company and its productivity. **Highly sustainable companies are in fact 10.2% more productive than unsustainable ones.** [22]

In this context, an overview of the country's progresses in each SDG shows that the Italian performance still has **large room for improvement** in many fields. As for the sectors: health, clean water, renewable energy, life on land, peace and justice, Italy is on track to reach the target set by the SDGs for 2030. However, more than half of the indicators show a moderate improvement for the country with an insufficient performance to reach the 2030 target or, worse, a stagnant situation, where many **unresolved challenges and unmet social needs** remain.

21 In 2013, Istat, together with representatives of the social partners and civil society, developed a multi-dimensional approach with the aim of integrating the information provided by economic indicators with the key dimensions of well-being, integrated by measures on inequalities and sustainability. The set of 130 indicators, covering the 12 domains relevant to the measurement of well-being, aims to make the country more aware of its strengths and the difficulties to overcome to improve the quality of life of citizens.

22 The European House - Ambrosetti elaboration on Istat data, 2019.

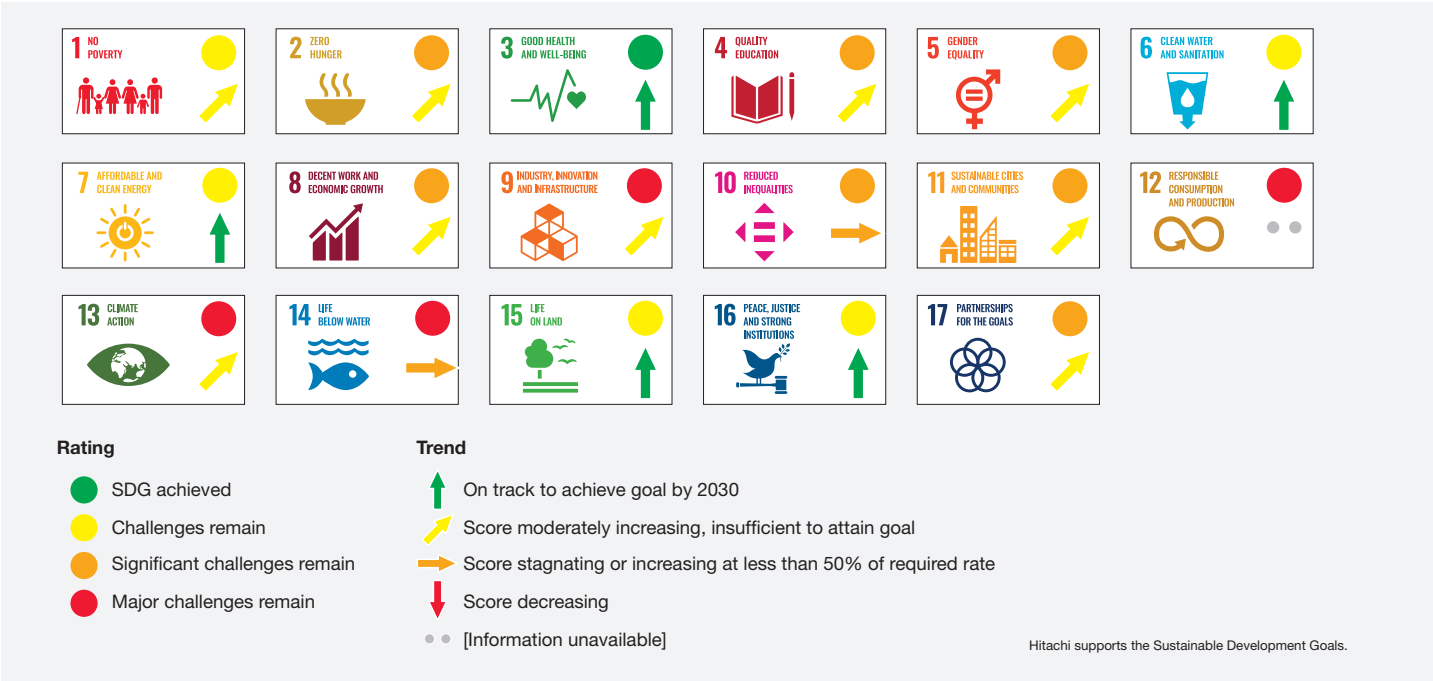

Figure 3.3: Positioning of Italy with respect to the achievement of the Sustainable Development Goals set for 2030, 2019.
Source: The European House - Ambrosetti elaboration on United Nations data, 2019.

In this context, Hitachi's contribution can be particularly important and positive. Not only because of the role that the Japanese multinational can play as a driving force for the creation of the Society 5.0 in Italy, as illustrated in the previous chapter, but also because many of the vulnerabilities that characterize the country belong to those areas, identified by the SDGs, on which the action of Hitachi focuses.

The following part of the study briefly analyzes the performance of Italy in the SDGs in which Hitachi can make a contribution through its business strategy or its corporate commitment, in order to better understand the scope of intervention and the main vulnerabilities to which the implementation of the Society 5.0 model, also through the action of Hitachi, can respond more effectively.

SDG 3: Ensure healthy lives and promote well-being for all at all ages

Despite having achieved the objective of "good health and well-being", there are still major inequalities hindering the access to the National Health Service, besides criticalities in terms of wellbeing and healthy living. Although in 2016 Italy reported a life expectancy at birth of 83.4 years, second best performance in EU after Spain, the gap between total life expectancy and healthy life expectancy is constantly widening.

Chronic diseases are also on the rise, a worrying figure considering that today 40% of the Italian population suffers from them (+5% by 2028) and half of it is affected by multi-chronicity. Deaths due to air pollution are another alarming data: in Italy the number of deaths related to poor quality of the air breathed equals 84,300 people, way higher than the 78,400 of Germany, 47,300 of France, 41,490 of the United Kingdom and 38,600 of Spain.

The length of waiting lists is a major health policy concern: in Italy 53% of patients have to wait beyond the 30-day limit (42% in 2013). A limit to the accessibility of services that adds to the presence of further regional disparities regarding the access and quality of facilities. The five worst regions national health system satisfaction correspond to the regions of Southern Italy. [23]

23 Eurostat, WHO, World Bank, OECD and IPS data, 2019.

SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

Although on track to achieve the objective set by SDG number 4, different challenges remain open, both in terms of training provision and access to education and training.

Italy is in fact the European country with the highest percentage of NEETs [24], with almost a third of young people not engaged in study, work or training. The difference with the European average is almost 13 percentage points. Italy also has a high rate of early school leaving: in 2018, Italy recorded a rate of early school leaving of 14.5%, compared to 10.6% in the EU.

Considering the public expenditure on education, Italy is among the European countries which spend less and the resources allocated by Italian Government in this area are constantly decreasing. In 2015, Italy allocated 3.3% of its GDP to spending on primary, secondary and tertiary education, compared to 3.5% in Spain, 3.6% in Germany, 4.2% in the United Kingdom and 4.5% in France. Public expenditure on education in Italy decreased by 12% between 2009 and 2015. [25]

From an entrepreneurial point of view, there are still few Italian companies providing training and, at the same time, few employees participating. In 2015, only 60.2% of Italian companies provided training courses, compared to 72.6% in the EU and 85.7% in the UK, while in the same year in Italy 45.9% of employees attended combined vocational training courses, compared to 65.3% in Slovenia and 55.4% in Spain. [26]

SDG 5: Achieve gender equality and empower all women and girls

Although Italy stands out on the European scene with one of the lowest gender pay gap, the progress made by our country to achieve the goal of “gender equality” is still not sufficient.

Indeed, women’s participation in the labor market is still low: Italy shows the lowest value in the EU after Greece. Taking only management levels into account, only 29% of managers are women, compared to an EU average of 36%. Moreover, in 2015, the percentage of women who participated in continuing vocational training (CVT) courses was 56.5, compared to 62.4 for men. [27]

Women also represent the largest part of the total share of part-time Italian workers. In fact, by 2018, the 3.1 million Italian part-time workers represented the 75% of total workers in this category. [28] This figure is particularly significant considering the high number of involuntary part-time workers: of these, in 2018 women numbered 1.9 million, still representing the main reference for child care and dependent relatives. [29]

The presence of women in Italy is also limited in the digital sector: women specialized in ICT (Information and Communication Technologies) represent 15.5% of the total, while the EU average is 17.2%. The number of women graduates in the STEM disciplines (Science, Technology, Engineering and Mathematics) is low: in 2016, for every 1,000 STEM graduates, 11.2 were women aged 20-29, compared to 16.4 men and an EU average of 13.1.

SDG 6: Ensure availability and sustainable management of water and sanitation for all

Although Italy is on track to reach the 2030 target in terms of sustainable water and sanitation availability and management, important challenges remain here as well. The national water sector suffers from multiple problems, especially of an infrastructural nature. This scenario is destined to worsen considering that the evolution of climatic conditions will determine a situation of water scarcity in Italy: in 2017 alone, the country registered a shortage of 20 billion cubic meters of water in the spring months, for a volume equal to almost 50% of the “reserve capacity” of the entire peninsula. [30]

Water stress is a widespread problem, a factor that, combined with the proven inefficiencies of the Italian water network (almost 50% of the drinking water withdrawn does not reach the end users due to network leakage) [31] highlights the necessity of a systemic effort to ensure adequate levels of water supply and storage for crisis management.

24 The term NEET (Not in Education, Employment or Training) refers to the proportion of the population who are neither in employment nor in education or training.
25 OECD data, 2019.
26, 27, 28 Eurostat data, 2019.
29 Istat data, 2019.
30 FAI (2018). The reduction in available water recorded was about 20 billion m^3.
31 ISTAT - Report on “ISTAT water statistics”, 2019.

In this context of fragility, Italy is the first country of the EU for water withdrawal (5,232.2 million m³ in 2017, 428 liters per inhabitant per day). Water resources are also poorly managed and inefficiently disposed, considering that 11% of the population is unable to benefit from treatment services. [32] The rate of safely treated wastewater flows is among the lowest in the EU: 88.4% in Italy, compared to 98.2% in Germany, 94.4% in the UK and 90.1% in Spain. In addition, urban wastewater treatment systems are scarcely developed. More than 100 Italian cities do not have a waste water treatment system and for this reason, in 2018, Italy has received a Community sanction from the European Court of Justice of €25 million, plus €30 million for every six months of delay in completing the required interventions. [33]

SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all

The situation is similar for what concerns the access to cheap, reliable, sustainable and modern energy systems. Firstly, electricity costs are particularly high in Italy, in a European context where energy costs represent one of the major obstacles for the competitiveness of the EU production and industrial system. In the second half of 2018, the cost of electricity for non-domestic use in the country was €0.14 per kWh, compared to an EU average of €0.11 per kWh. Considering electricity prices for household customers, the highest prices for the last decade were recorded in 2018: 21,76 c€/kWh. [34]

Grid stability and service quality in terms of coverage is also worsening: in 2017 electricity grid losses were 6.2% compared to 4.2% in Germany and 4.0% in Spain and compared to an average of 6.1% in the EU, showing ample room for improvement. A growing stress on the national energy system's efficiency is also signaled by the growing time of interruption of the electricity supply service: between 2007 and 2017 the time lost by customers due to long-term [35] interruptions increased by 19.5 minutes, highlighting a growing stress on the energy sector.

Considering the objectives set by the European framework for 2020, Italy has a good performance in the use of renewable sources, with 16.1% of total final energy consumption covered by clean energy. Nevertheless, this value is still limited when compared to the southern European average (18.3%), or to that of northern Europe (25.7%) and considering the progressive phasing-out of public incentives to the sector.

Finally, the energy intensity of our country remains high: in 2016 the ratio of gross domestic energy consumption to GDP was in fact 24 p.p. higher than in the EU. [36] According to the most recent data provided by ENEA (National Agency for New Technologies, Energy and Sustainable Economic Development), 2018 also saw an increase in energy consumption (+1% over the previous year). 2018 signs the fourth consecutive year in which energy consumption moves in parallel with economic growth, while a central element of decarbonization is represented by an increase in energy consumption more contained than GDP (so-called decoupling). This is also confirmed by the worsening of the ENEA ISPRED index (-8% on an annual basis) which assesses the performance of the national energy system on the basis of three key elements: energy security, prices and carbon dioxide emissions.

SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Although labor market conditions in Italy have gradually improved, with unemployment returning to pre-crisis levels and the employment rate at the highest levels since the existence of the historical statistical series, Italy's performance is insufficient to reach the 2030 target in SDG number 8.

The country's performance is affected by unemployment, which, although falling, is more serious than in the rest of Europe. According to the latest data for August 2019, the unemployment rate recorded in Italy (9.5%) was lower only in Greece (17.0% in June 2019) and

32 Utilitatis – "Blue Book 2019", 2019.
33 Istat, UNStats, European Federation of Bottled Water and Eurostat data, 2019.
34 ARERA – "Trend in the price of electricity for the typical household consumer in greater protection", 2019.
35 Defined as a decrease in the supply voltage level to zero for more than 1 minute.
36 WorldBank, UNStats, ARERA, Terna, EEA and Eurostat data, 2019.

Spain (13.8). A similar situation applies to youth unemployment, with Greece having the highest rate in August (33% in the second quarter of 2019), followed by Spain (32.2%) and Italy (27.1%).

An international comparison of the wage component shows that: the standard purchasing power of the average gross hourly wage of an Italian employee is €12.1, lower than the European average of €13.2, the French average of €13.9 and the German average of €15.4. [37]

Considering the quality of work and safety in the workplace, Italy has a higher number of fatal accidents at work than the EU average: for every 100,000 people employed there are 2.4 fatal accidents in Italy, compared to 1.8 in the EU.[38] Finally, Italy is also one of the EU countries with the highest number of hours worked, while labor productivity is stagnating.

SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Considering SDG number 9, Italy is still far from reaching the 2030 target, showing how a systemic participation of the entrepreneurial and productive fabric and consumers is central to the realization of a sustainable society, able to respond to present and future social challenges and needs.

Investments in Research and Development (R&D) to national GDP (R&D intensity) are inferior to the major European competitors: 1.4% of GDP compared to 2.0% in the EU, an OECD average of 2.4%, 3.0 in Germany, 3.2% in Japan and 4.6% in South Korea. Despite the increase in R&D personnel (from 13 per 10,000 inhabitants in 2004 to 22 in 2016), the gap remains particularly marked in terms of lack of human resources, with an incidence of researchers on the Italian population of just over a quarter compared to Denmark, Sweden and Finland, a number of 2.1 per million inhabitants, against an EU average of 3.3.

Considering infrastructure, even if the country is progressively equipping itself for service digitization and for a more accessible domestic use of the network, the situation does not improve in terms of physical infrastructure (roads, railways, ports, airports, ...). According to the audit conducted in 2018 by the European Court of Auditors, Italy is the country in the European Union with the highest construction cost for high-speed rail lines already completed (28 million euros per kilometer, compared to 12 million in Spain, 13 million in Germany and 15 million in France). If the projects already completed are added to those in progress, the cost per kilometer for Italy rises to 33 million, versus 14 million for Spain and 15 million for Germany and France. Italy also has the longest delays in EU in the average time taken to complete the works, which have remained almost unchanged over the years (4.4 years in 2018 compared to 4.5 years in 2014). [39]

In the light of the present weaknesses of the infrastructure system, it is not surprising that the use of rail transport in Italy is scarce: only 6.1% of Italian passengers move by train against an EU average of 7.7%. As far as goods are concerned, 14.7% of Italy's goods travel by rail, which is lower than the EU average of 17.6%. [40]

SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable

In terms of "sustainable cities and communities", Italy still faces significant challenges and the improvements achieved so far are not yet sufficient to achieve the goal set by the United Nations.
In Italy, soil consumption increased at an annual rate of 2 square meters of soil per second: cementing was 54 km^2 per year. The rate of soil wear has stabilized in recent years, but the reversal of the trend is that the European targets for zero net land consumption are far off from being achieved. Increasing urbanization, improper agricultural practices and contamination by productive activities are all contributing to the

37 Eurostat data, 2019.
38 Eurostat data, 2019.
39 The audit was carried out on high-speed lines in six European countries and analyzed more than 5,000 km of infrastructure on 10 high-speed lines covering about 50% of those currently existing in Europe. See European Court of Auditors, A European High-Speed Rail Network: Not a Reality but an Ineffective Patchwork, Special Report, 19, Luxembourg, 2018. Source: Bank of Italy.
40 WorldBank, UNStats, IVASS and Eurostat data, 2019.

progressive degradation of soils and to an increasing risk of disasters. In the last six years Italy has lost areas that could have produced 3 million quintals of agricultural products and 20,000 quintals of wood products, ensuring the infiltration of more than 250 million cubic meters of rainwater that now, flowing to the surface, are no longer available for the recharge of the aquifers. Recent land consumption is causing potential economic damage of between €2 and €3 billion per year, due to the loss of the land ecosystem.

Traffic constitutes another major issue. Italy is third in the EU for hours per capita lost in traffic due to road congestion each year: this value is 37 hours per capita / year, compared to 29 in Germany and 30 in France. The congestion caused by traffic, with 15.7 micrograms per cubic meter of fine particulate matter, compared with 14.2 micrograms in the EU, makes the Italian urban air quality one of the worst in the EU, endangering the health of its citizens.[41] Of the 422,000 premature deaths that occurred in Europe in 2015 due to air pollution, 60,600 were Italian.[42]

SDG 12: Ensure sustainable consumption and production patterns

As regards the SDG "responsible consumption and production", Italy has several strengths, recording significant progress in terms of consumption of resources (between 2000 and 2014 the consumption of domestic material has decreased by about 50%, starting to grow again from 2015). In the European context, Italy has the third lowest ratio of material consumption/GDP. However, this progress is set against the background persistent elements of vulnerability, especially with regard to the establishment of circular models, resource use and recovery.

Waste production in the country has not improved over the years: between 2006 and 2016 Italy increased its per capita waste production by 266 kg, while the EU on average decreased this value by 123 kg. Italy's vehicle recovery and reuse rate of 82.6% is 10.1 percentage points below the EU average. A similar situation emerges when looking at electronic waste correctly disposed for recovery: the Italian figure stands at 34.4%, 6.8 percentage points lower than the European average.

SDG 13: Take urgent action to combat climate change and its impacts

The effort to adapt to and combat climate change in our country faces a variety of challenges, including hydrogeological instability, desertification and coastal erosion, aggravated by extreme events, as well as the defense of biodiversity.

Temperatures reached a new record in 2018, the hottest year since 1800 according to data provided by the Institute of Atmospheric Sciences and Climate of the CNR[43], while, 2017, the driest year since 1800, with 31% less precipitation than the long-term average. Extreme temperatures expose our country to a strong fluctuation in the availability of water resources and a growing risk of desertification. Italy is among the thirteen EU Member States at risk[44]: while this threat affects 8% of EU territory, 25% of Italy's surface is exposed.

Between 2010 and 2018, 437 natural phenomena affected our country causing damage (hardship, damage to infrastructure, victims) and 264 municipalities recorded events with significant impacts. 189 people have been victims of bad weather since 2010, with 32 deaths in 2018 alone, in addition to the evacuation of more than 45 thousand people due to events such as landslides and floods.[45]

The efforts made so far have not been sufficient to achieve the 2030 target set by the United Nations. Even considering the shorter-term targets set by the EU for 2020, Italy's progress seems insufficient. Considering 1990 as the index year, the reduction in the country's greenhouse gas emissions was lower than the European average (17.4% vs. 23.5%), struggling to keep up with the pace necessary to achieve the 2030 objectives and the 60% target set.[46] With 8 active carbon plants, in 2017 Italy

41 ISPRA, Eurostat, EEA and UNStats data, 2019.
42 European Environment Agency data, 2019.
43 With an anomaly of +1.58°C above the average of the reference period (1971-2000) it exceeded the previous record of 2015 (+1.44°C above the average).
44 According to the latest World Atlas on Desertification developed by the EU Joint Research Centre.
45 Legambiente - Climate risk map, 2018.
46 Eurostat data, 2017.

consumed 15.2 million tons of hard coal, more than those consumed by France (14.8) and the United Kingdom (14.2).

SDG 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development

The Italian contribution to the creation of a "global partnership for sustainable development objectives" sees Italy making insufficient progress towards achieving the objective. The analysis done takes into account especially those factors that enable the sharing of sustainable practices and the dissemination of greater knowledge on the subject, such as the propensity to cooperation between the various actors of society, on a national and international scale, and the presence of a digital infrastructure to support the implementation of the new business models.

Even if the country takes part in most of the sustainability agreements, the lack of openness with regard to innovation has a negative impact on the goal achievement. The number of international scientific co-publications in which Italy takes part is in fact limited. Although the Italian average of co-publications per million inhabitants is above the EU average (596 vs. 501), in 2016 it was lower than in the UK, Germany, Spain and France. The scarce propensity to creative collaborations reflects into a limited number of forms of cooperation between innovative companies and other actors: compared to the EU, large Italian companies collaborate less with universities, governments and research centers (14.8% vs. 23.1%). For SMEs, the percentages are 3.3% compared to the EU average of 7.4%.[47]

Italy's low digital propensity places the country at 25th place out of the 28 EU countries, according to the International Index of Economics and Digital Society (DESI). Internet access and digital education represent complex issues, also considering the disparities within the country: the gap in Internet use between Northern and Southern Italy in 2017 recorded a difference of more than 10 percentage points. Moreover, Italy records a share of households located in cities with internet access (on total households) lower than EU average (84% vs. 89%) and below the level of major competitors.

Hitachi contributes to the achievement of these objectives both through its business strategy and through its corporate commitment. In the next chapter, both dimensions will be analyzed through impact analyses aimed at quantifying the contribution linked to Hitachi's presence and activity in Italy from an economic, social and environmental point of view. The analysis of the case studies selected, all developed by the Group in Italy and Europe, allows to deepen the actual and potential contribution of Hitachi to the development of 5.0 Society, in terms of technological innovations and adoption of organizational and collaborative models that, as explained in previous chapters, constitute the basis for the identification of innovative solutions to address social problems and challenges for a fully sustainable development.

47 Eurostat, ASVIS and European Commission data, 2019.

04 Hitachi's presence in Italy and its contribution to value creation and to the Italian path towards a sustainable society

Hitachi's distinctive features, as described in the previous chapters, together with its vision of solving social and environmental problems to implement an inclusive, harmonious and prosperous society through innovative solutions and a collaborative approach, make the multinational company a **key business player** in the Italian path towards growth and sustainability. >

The analysis of Hitachi's value creation for Italy and its contribution to the advancement of Society 5.0 takes into consideration two different dimensions. Firstly, this chapter examines the contribution of "One Hitachi" – intended as a whole comprehensive of all Hitachi's firms and business entities with a direct presence and activity on the Italian territory – and its corporate commitment in creating multidimensional value (economic, social and environmental) and paving the way towards the implementation of Society 5.0 in Italy.[48]

The second part of this section shifts the focus on Hitachi's business strategy and to companies' distinctive features/performance contributing to the formation of economic, social, or environmental value in Italy, through a selection of case histories on Hitachi's Social Innovation, underlining the value of innovative products, services and solutions in responding to society's challenges.

4.1 One Hitachi presence in Italy and its corporate contribution to Society 5.0 in the country

"One Hitachi"'s presence in Italy (12 Group Companies [49]) is characterized by a wide geographical spread– with a direct presence in 14 Italian Regions, and a variety of sectors of activity. High technology solutions find application in many business areas, from the rail sector and metals to information technology, automation, water and energy management, dealing as well with the healthcare system (diagnostics). The intrinsic value of One Hitachi lies exactly in the **impactful synergies** enabled by the coexistence of these many souls, each characterized by a distinctive know-how, highly competitive and innovative in its field, which together, in a synergistic and integrated perspective, generate a higher value.

A pervasive presence throughout the country and unique knowledge and expertise in a variety of sectors contribute, directly or indirectly, to overcome the challenges that the country faces, hindering the potential that would derive from the implementation of a truly sustainable society.

48 This section retrieves, updates and deepens the evidences and information coming from the previous research study by The European House – Ambrosetti "Hitachi's Value for Italy", carried out in 2017. Through the adoption of the multidimensional 4 Capitals model, the paper collected the most appropriate key facts and figures to measure, evaluate and underline the Group's contribution to the growth of the territorial capital, intended as the sum of the economic, social, knowledge and environmental value.

49 In addition, on December 17, 2018, Hitachi announced an agreement with ABB for the acquisition of its world-leading power grids business, to be completed and making Power Grids a consolidated subsidiary in 2020.

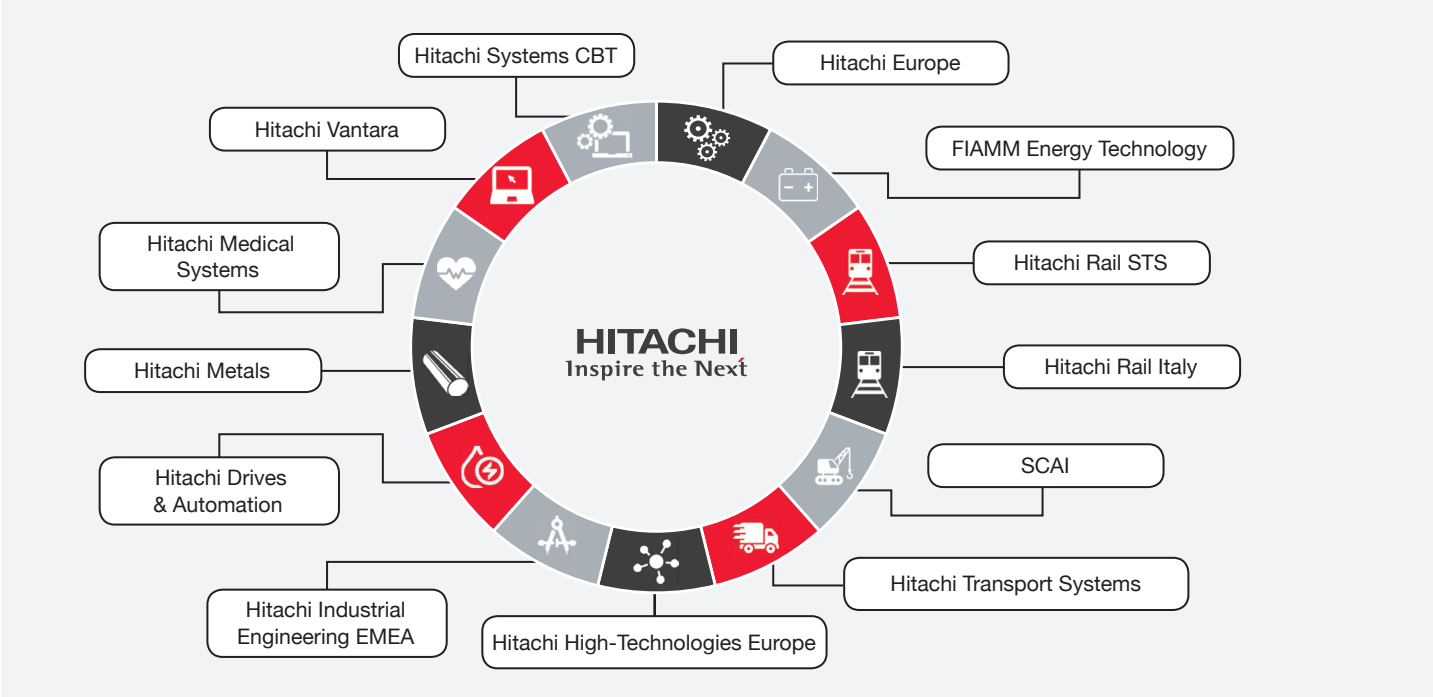

Figure 4.1: Hitachi's major Group companies active in Italy.
Source: The European House – Ambrosetti elaboration on Hitachi data, 2019.

Economic growth is a key component of sustainable development, SDGs explicitly encourage sustained economic growth by achieving higher levels of productivity and through technological innovation, becoming the means to drive progress and implement full and productive employment, and decent work, for all women and men by 2030.

From an economic standpoint, Hitachi contributes to the Italian economy with revenues, exports and investments growing at a faster pace than the national average.

First of all, Hitachi is steadily growing in terms of revenues. Considering 2018 revenues, One Hitachi would be at the **16th** position among foreign-owned companies in Italy and **74th** among all industrial and services companies. [50]

One Hitachi revenues have grown with a CAGR [51] of +**12%** between 2015 and 2018 thanks to a general increase in business activities, moving from €1,691 million to a cumulated value of **€2,373 million**. One Hitachi has overperformed the rise of Italian average industrial and services companies' revenues [52] (+2.1%) as well as the growth of the manufacturing sector, which registered a +3.1% increase [53] in the same period. Moreover, considering the major industrial and tertiary companies of the country, this growth rate positions One Hitachi as the **2nd fastest-growing foreign-owned company** in Italy, the **5th in the whole ranking**. [54]

This is particularly important considering the role that large companies play in the Italian economic and productive fabric, characterized by a significant share of small companies with less than 10 employees (95% of the total) [55], which are associated with poor economic performance, and that Italy is first in the EU for micro-enterprises' (less than 10 employees) share of the total.

In Italy, **large companies perform on average better** than small ones: in 2015, enterprises with a turnover of more than €500 million recorded an EBITDA equal to 9.7% of sales, a value that progressively declines as turnover decreases, until reaching a 7.2% share for the companies with revenues in the range of €10 and €20 million. [56]

50 The European House – Ambrosetti elaboration on Mediobanca data, 2019.
51 Compound Annual Growth Rate.
52 The European House – Ambrosetti elaboration on Mediobanca data, 2019. The 2019 Report "Dati cumulativi di 2095 Società Italiane" shows the cumulative balance sheet data of 2,095 mainly large and medium sized industrial and tertiary companies, covering the 49% of the industry turnover.
53 Data refers to the manufacturing enterprises belonging to the 2,095 companies' cluster, covering the 51% of the sector turnover.
54 The European House – Ambrosetti elaboration on Mediobanca data, 2019.
55 Istat data, 2019.
56 The European House – Ambrosetti elaboration on AIDA data, 2019.

With respect to their European competitors, Italian companies are less productive, a gap that is exacerbated in the case of micro-companies.[57] The smaller the firm, the lower the value created, as well as the resources available to sustain growth and to innovate.

The contribution of a company is measured not only from a direct point of view, but also from an indirect and induced one, which is related to the activation of supply and sub-supply chains. Since every company operating in a production sector produces an output by purchasing and combining together some inputs from other industries, each economic sector, as a whole, places itself on the market with a dual role: buyer of goods and services to employ in the production process; seller of the goods produced to other economic sectors. The wages and salaries paid by the sector to its employees feed the disposable income and, according to the propensity to consume, the demand for goods and services, thus generating a **multiplier effect**. To calculate the effect of One Hitachi on supply and sub-supply chains, **input-output matrices** of sector interdependencies were used. Specifically, the input-output system statistically analyzes the interactions between the industrial and productive sectors of a nation and through a matrix scheme offers a synthetic representation of its internal and external relations.[58]

By applying the methodology on One Hitachi's revenues, the input-output analysis shows how the Group has an important multiplier effect on the Italian economy. In our country, Hitachi's multiplier of 1.95 generates a total value of **€4.6 billion**, summing up direct, indirect and induced value, of which €3.8 billion in the manufacturing sector. This means that **for each €1** of One Hitachi's revenue in Italy, **€0.95 of additional revenues** are activated within the entire economy. [59]

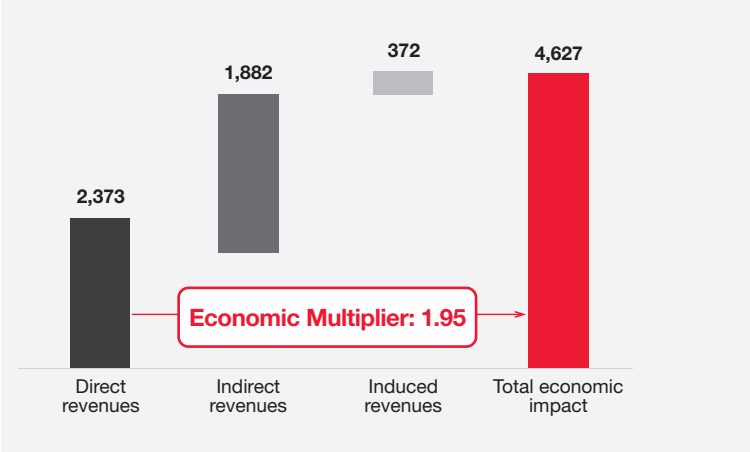

Figure 4.2: Direct, Indirect and Induced revenues of One Hitachi (€ million), 2018. Source: The European House – Ambrosetti elaboration on Hitachi data and own calculations and econometric modelling using Input/Output tables of Istat, 2019.

In addition to turnover, One Hitachi's exports positively contribute to the Italian commercial trade balance and, at the same time, leverage the country's distinctive competences and know-how. Export is one of the main drivers of economic growth: it favors the internationalization of the industrial fabric, contributes to increasing the innovative potential of a country, and supports the competitiveness of an economy.

One Hitachi's value of export from Italy more than doubled between 2015 and 2018, from €531 million to €1,145 million, recording a positive CAGR of +**29.2%**, twelve times higher than the growth registered in the same period by the national industrial and services companies' export (+2.5%) [60]. This cumulated value represents a significant component of the Group companies' business: **almost half of the revenues**, 48%, derives from exportation. This percentage is even higher considering the specific case of FIAMM Energy Technology [61] (**67%**), the highest value together with Hitachi Rail STS [62] (**61%**).

57 The European House – Ambrosetti elaboration on Eurostat data, 2019.

58 The internal relations are determined by the production and circulation (purchases and sales) of goods among the various sectors in which an economic system is articulated, and the external ones through imports and exports.

59 The European House – Ambrosetti elaboration on Hitachi data and estimation using Istat Input/Output tables, 2019.

60 Data refers to the Mediobanca's cluster of 2,095 industrial and tertiary companies.

61 FIAMM Energy Technology is a multinational company active in the production and distribution of automotive and industrial starter batteries, created following the separation from the FIAMM Group of the automotive and industrial batteries business.

62 Hitachi Rail STS (previously Ansaldo Signaling and Transportation Systems or Ansaldo STS) works in the field of railway signaling and integrated transport systems for passenger traffic and freight operations.

Moreover, One Hitachi directly **contributes to Italian GDP** through the generation of Value Added. [63] In 2018 One Hitachi Value Added reached **€283 million**, increasing the 2015 value of €133.5 million and its GDP contribution by a 28.5% CAGR. In terms of value creation, it is a better performance than the one registered by the industrial and services companies' [64] in the same period: in the last four years their average Value Added recorded a +2.5% CAGR.

In addition, Hitachi contributes to the Italian economic performance considering productivity.

Made up by different components – labor productivity, capital productivity and multifactorial productivity – a residual element influenced by "soft" factors, such as organizational and managerial skills, digitization and bureaucracy and economic environment – productivity represents the proxy of the companies sustainability in terms of efficiency and effectiveness and the ability of the country to transform its assets into **long-term value** and sustainable **economic growth**.

Productivity growth has been slow in Western countries since the global financial crisis, but Italy has been suffering from a long-lasting stagnation for 25 years. This constitutes a central problem for the Italian growth especially for the long-term perspective, since it is key to increasing per-capita incomes and lowering the debt-to-GDP ratio. Low productivity levels, coming from a scarce capability to combine the various factors of production through new ideas and technological innovations and processes, together with a growing public debt burden, in fact, heavily hinder Italy's economic growth.

While labor productivity has decreased by 0.3% between 2016 and 2018 [65] in Italy, One Hitachi Value Added per employee has risen from €46,719 to €51,160, with a positive CAGR of **4.6%**, offering a contribution of opposite sign. If Italian productivity had grown in line with Hitachi's performance, between 2016 and 2018 Italian GDP would have increased by **1.8%**.

The last element through which One Hitachi contributes to Italian economic sustainability is related to **investments' performance**. Investments represent the main driver for productivity and growth, a concrete contribution to the creation of a favorable ecosystem capable of maximizing the inputs' value. A positive relation between investments, especially in innovation, and productivity is demonstrated with beneficial implications also on GDP.

In a country where investments are continuously falling, both public and private, Hitachi is countertendency. [66] In this context, in 2018 One Hitachi's investments reached a cumulated value of **€98.8 million, four times** as much the value of 2015 (€22.5 million), recording a +**63.7%** CAGR.

From a social standpoint, One Hitachi plays an important role in terms of employment. The Group has been increasing its total labor force: between 2015 and 2018 the number of employees has grown from 4,012 to a total of **5,532 employees**, recording a +11.3% CAGR [67], **10 times** the rate of national employment growth (+1.1%), higher also than the CAGR of employment growth in Italian manufacturing sector (+1.0%) and services (1.3%) between 2015-2018. [68] One Hitachi is the **first foreign-owned company in Italy in terms of employment growth rate** (2015-2018), the **6th** Group in the full ranking of the major industrial and tertiary companies of the country. [69]

Moreover, Italian employment performance shows a sharp regional disparity, with a cleavage between Southern Italy's unemployment rate and that for Northern Italy: the unemployment rate in southern Italy is **3 times higher** than in the North. [70] Four out of five of the Regions with the lowest employment rate in Europe are in Southern Italy with less than half of the people aged between 20 and 64 having a job compared to 73.1% on average in the EU.

Within this context, One Hitachi provides an important contribution to contrasting these regional imbalances,

63 Value Added is given by production value - (cost of purchasing raw materials + change in inventories of raw materials + cost of services and use of third-party assets + operating costs).
64 Data refers to the Mediobanca's cluster of 2,095 industrial and tertiary companies.
65 The European House – Ambrosetti elaboration on OECD data, 2019.
66 The European House – Ambrosetti elaboration on Eurostat, OECD and European Commission data, 2019.
67 The rate of organic growth, excluding acquisitions, is +4.9%.
68 The European House – Ambrosetti elaboration on Istat data, 2019.
69 The European House – Ambrosetti elaboration on Mediobanca data, 2019.
70 Istat data, 2019. The unemployment rate in 2018 was 18.4% in the South, vs. 6.5% in the North.

with a well distributed presence throughout the national territory and a presence of work strength that is more **concentrated in the South** than in the North of the country.

Moreover, jobs provided by Hitachi are characterized by high quality in terms of skills development, know-how sharing, stability and growth prospects.

The KPIs taken into consideration for the social capital analyze the characteristics of employees' profiles, drawing a picture of an average employee aged **43.5** – younger than the Italian average – in **99%** of cases with a **permanent** contract (vs. 87% of the national average). This is a remarkable element if contextualized in the national job market.

This contribution is particularly relevant due to the fact that Italy faces high unemployment rates. While the employment rate improved in 2018 (63%; +0.7 compared to 2017), recovering, for the first year, the pre-crisis levels, the differentials with respect to the EU average (-10 p.p.) and in terms of youth ,18 p.p. lower than the EU average, are still significant. [71] Moreover, in the country the youth unemployment rate is close to 40% and over two million young people do not study or work: the share of NEETs aged 25-29 in 2018 is the highest in Europe (30.9%).

The generation of value across Italy also depends on the education and the training opportunities of its human resources: One Hitachi's labor force level of education is **higher than the Italian average**, and it is constantly investing in knowledge development for its employees. University graduates are the majority (40% vs. a national average of 23%), followed by employees with a high school diploma (53% vs. 46%) and other [72] (7% vs. 31%). [73]

Also in this case, as with turnover, the contribution of Hitachi to employment is not limited to a direct point of view: indirect and induced employees activated by direct jobs provided by One Hitachi must be included in the analysis. Additional employees are mobilized by each company through the activation of supply and subcontracting supply chains and the effect on consumption.

Considering One Hitachi's supply chain and the characteristics of its workforce, **for each** job directly created by Hitachi, **1.4** additional workplaces are activated in the economy. Given so, One Hitachi's overall contribution to the Italian employment totals almost **13,300** people in 2018. [74]

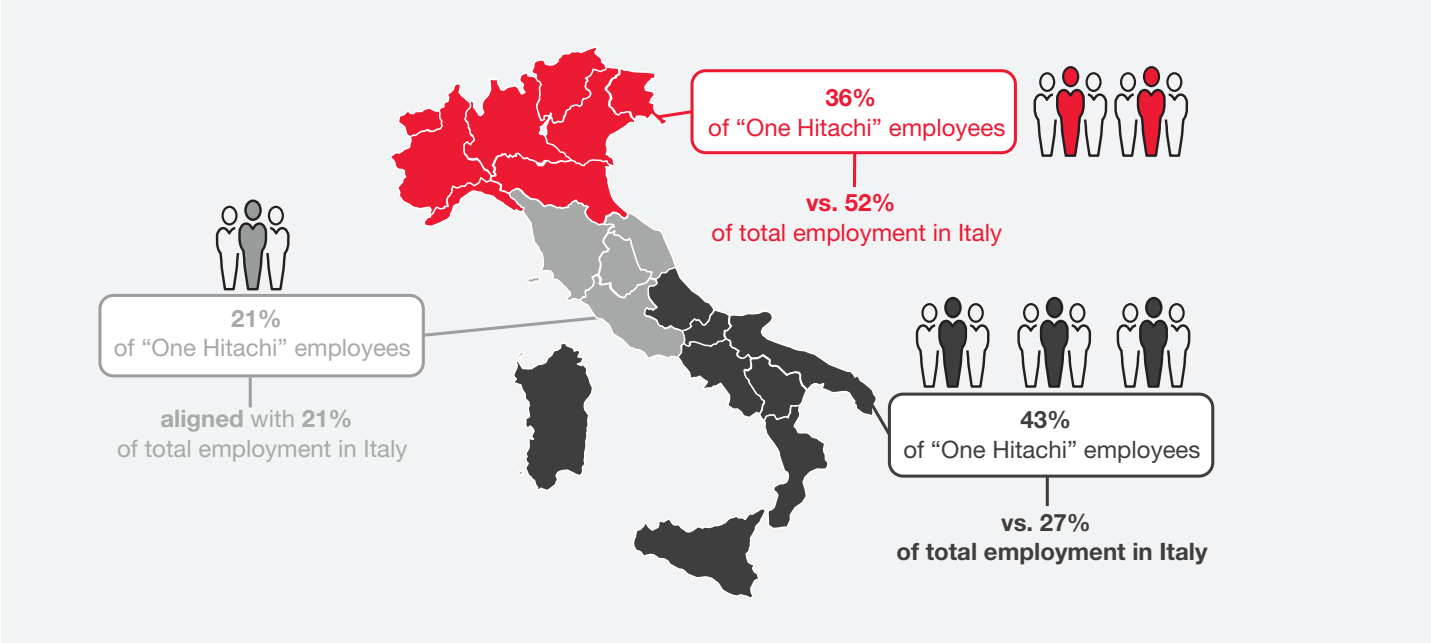

Figure 4.3: One Hitachi contribution to the Italian employment (% of total workforce per macro-region), 2018.
Source: The European House – Ambrosetti elaboration on Hitachi and Istat data, 2019

71 Eurostat data, 2019. Youth employment refers to the 15-24 group.
72 Other refers to primary school and lower secondary school.
73 The European House – Ambrosetti elaboration on Hitachi and Istat data, 2019.
74 The European House – Ambrosetti elaboration on Hitachi data and estimation using Istat Input/Output tables, 2019.

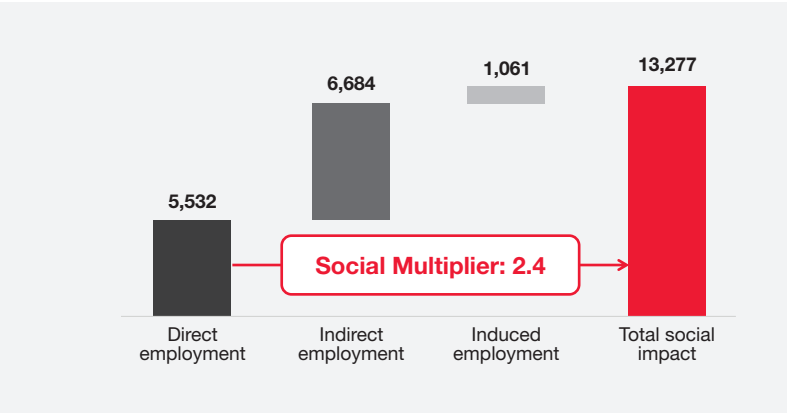

Figure 4.4: Direct, Indirect and Induced employment of One Hitachi (n. of employees), 2018. Source: The European House – Ambrosetti elaboration on Hitachi data and own calculations and econometric modelling using Input/Output tables of Istat, 2019.

In a country with a limited use of Open Innovation and delays in digitalization and Internet of Things, One Hitachi contributes to the development of the social capital also through cutting-edge R&D activities and relevant investments. One Hitachi has a high number of patents in force: in 2018 they were **247** (217 with national validity and 30 international), with a patents/employees rate **3 times** higher than the national one. This shows a **high efficiency** in translating these efforts into published patent applications. One Hitachi has **44.6** patents in force every 1,000 employees, while the Italian average is of 13.6 per 1,000 employees. If Italy had the same rate, the country would be third in the EU after Luxembourg and Ireland, while now it is ranked 12th.[75]

Finally, from an environmental perspective, Hitachi is directly committed to contributing to the environmental value of the territories in which it operates, not only through the provision of innovative and sustainable solutions for its clients and customers (aimed at the implementation of circular economy mechanisms, inefficiencies and waste reductions, etc.) but also improving the **environmental performance of its plants.**[76]

Considering energy efficiency, thanks to own proprietary model and investments, over the last two years, Hitachi has enhanced its performances **reducing gas consumption** by 10.9%, passing from 190.9 Gigajoule per € million revenues to 170.1 in 2018. In the same year, the performance of the manufacturing sector average has recorded a value of 372.6 GJ/€, more than the double.

Accordingly, its **electricity** has dropped by 8.6% (from 292.4 GJ/€ million to 267.3) between 2016 and 2018, reaching a value significantly lower with respect to the Italian manufacturing performance of 422.1 GJ/€ million revenues.

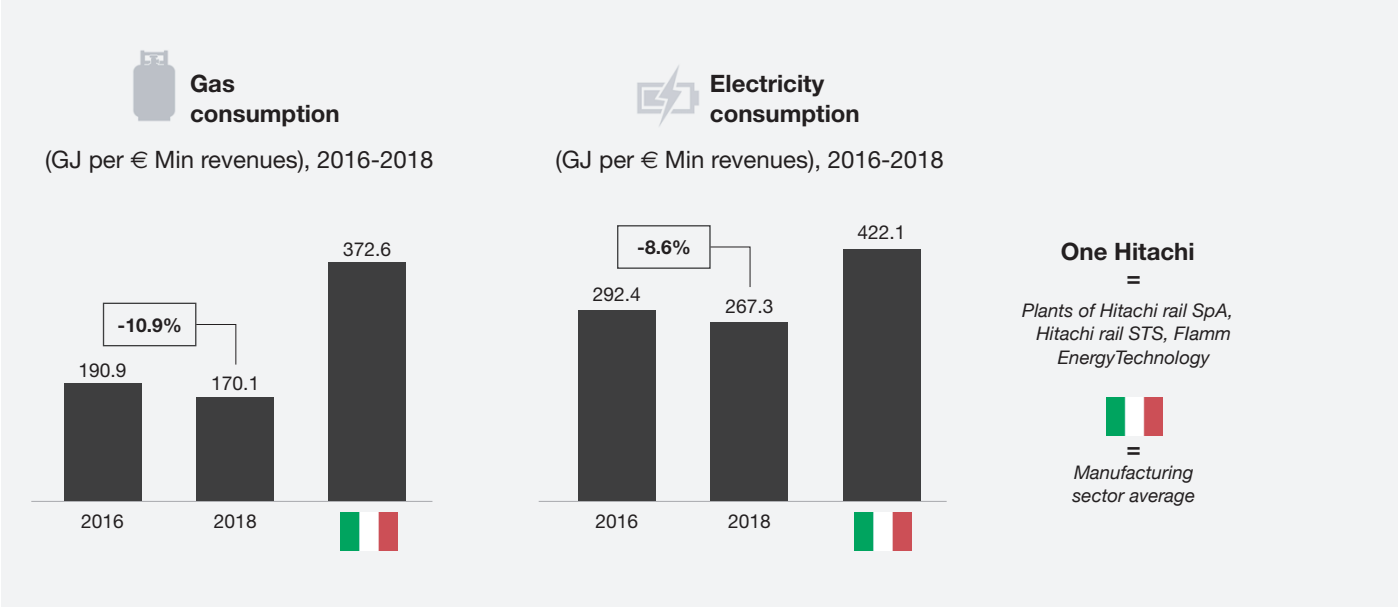

Figure 4.5: Gas and electricity consumption of One Hitachi and Italian manufacturing sector average (GJ per € million of revenues), 2016 and 2018. Source: The European House – Ambrosetti elaboration on Hitachi, Eurostat and Istat data, 2019.

75 The European House – Ambrosetti elaboration on WIPO and OECD data, 2019.
76 Data takes into consideration the plants of Hitachi Rail SpA, Hitachi Rail STS, FIAMM Energy Technology with respect to the Italian manufacturing sector average.

One Hitachi has also reduced its environmental impact, with waste production diminished by 8.7%, from 2016 value of 6.9 tons per € million revenues to 6.1 in 2018, almost 5 times lower than the Italian manufacturing average (28.8). One Hitachi performs better also in terms of CO_2 emissions compared to the manufacturing sector average performance: 31.5 tons/€ million revenues emitted in 2018 vs. 92.0.

While companies have a huge role to play in driving climate change, the trade-off between short-term profitability and the urgent need to reduce emissions can hinder the adoption of urgent and necessary actions towards the protection of our planet. Besides a **growing attention** towards environmental issues, the Italian path towards a sustainable and green energetic supply is undermined by high energy costs, elevated dependency on imports (the country is the fourth-largest energy consumer in Europe, after Germany, France, and the United Kingdom [77], and in the last 5 years its national energy balance has recorded a deficit increase of 8.3% [78]) and stagnant energy efficiency improvements. In this context, Hitachi's commitment and contribution stand out even more.

4.2 Hitachi's technologies and innovativeness contribution to create Society 5.0 in Italy

To analyze Hitachi's business' contribution, The European House – Ambrosetti has selected a limited number of business cases, indicative, even if not exhaustive, of Hitachi's technological and innovative capability to contribute to a country's sustainable development from an economic, social and environmental standpoint. The first group of cases present technologies realized or under development at European and international level, but capable of delivering results within the Italian society if implemented in the country. The second group of cases refers specifically to distinctive models or technologies that Hitachi is realizing or has already realized in Italy.

The framework of the analysis encompasses a brief contextualization of each case, followed by the overview of its major features and distinctiveness. An analysis of the Italian social needs that are addressed by the model or by the technology presented has also been realized, highlighting the importance and the effective contribution that a systemic technological player can provide to solve Italian social needs in **3 fields**:

1. Economic impact
2. Social impact
3. Environmental impact

Finally, an **impact analysis** is summarized, in order to estimate quantitative and concrete results of the case study application within the Italian country-system. Each case study closes with the key takeaways summarizing the business contribution it provides to Society 5.0 creation in Italy.

4.2.1 Artificial intelligence's concrete application to improve maritime sector's sustainability: A.I. Captain

Maritime transport emits around 940 million tons of CO_2 annually and is responsible for about 2.5% of global greenhouse gas emissions [79], a number projected to increase between 50% and 250% by 2050 if mitigation measures are not put in place swiftly.

Different technical and operational measures, such as slow steaming and propulsion efficiency devices, can deliver more fuel savings: there is significant untapped potential to reduce shipping emissions cost-effectively. Moreover, while in the past routes have been defined based on human experience this is not sufficient anymore: the existing technology can help companies to schedule the most efficient journey, taking into consideration the combination resulting from weather conditions, shallow water and speed through water.

In 2018, Hitachi developed a software solution to increase the **efficiency of naval fleets' operations**, improving their safety and reducing fuel consumptions together with greenhouse gasses emissions.

77 U.S. Energy Information Administration (EIA) data, 2019.
78 The European House – Ambrosetti elaboration on Ministry of Economic Development data, 2019.
79 International Maritime Organization – Third IMO GHG Study, 2014.

HITACHI'S SOLUTION

Hitachi's solution, developed together with **Stena Line** - one of Europe's leading ferry companies with 38 vessels and 21 routes in Northern Europe - makes extensive use of **Artificial intelligence technologies** to perfect the routes followed by ships, taking into consideration extremely variable elements, such as wind conditions, water depth and sea currents, allowing the identification of the optimal path to minimize gas mileage.

The AI simulator, considering the different surrounding elements within the maritime environment, analyses the potential scenarios and **offers the best option to reduce the emissions** of the ship deriving from its fuel consumption. Additionally, the software, receiving feedbacks from captains, learns from previous experiences (machine learning).

Hitachi's AI assistance is enabling Stena Line to become a **cognitive ferry company**. The implementation of this technology contributes to the achievement of a **more sustainable** maritime sector, in line with the directives set by the International Maritime Organization of reducing CO_2 emissions by 50% within 2050 (vs. 2008) [80]. Smart solutions play a crucial role, considering that the European Commission estimated that just using the current technologies the maritime transportation sector could cut its emissions by 75%.

The adoption of a **co-creation methodology** (a distinctive element of Hitachi's approach) enabled the design of the best software for the necessities of Stena Line. The crucial element to create an effective solution is the combination between the human element, represented by the Captains' experience, and a continuously learning technology, receptive to the inputs of the crew. [81]

THE ITALIAN SOCIAL NEEDS ADDRESSED

Within the Italian context, sea transport is a cornerstone for the economy and is strongly growing, even at higher levels than those before the crisis, recording in 2018 +11.3% of jobs and +12.6% of revenues compared to 2008. [82] In 2017, the 11,234 companies operating in the transport of goods and passengers generated an Added Value of €8.1 billion, employing 103,000 people.

Italy, with 9,000 km of coastline, is also the 3rd European country for goods traffic in the Mediterranean and, with 473 million tons handled, it is first in the EU 28 for short sea shipping. The sea absorbs 37% of Italian trade, a value that in 2018 has reached €253.7 billion and that forecasted to grow between 2019 and 2023 with an annual average rate of 3.8%. [83]

At Italian and European level sea transportation is a key element in the Trans-European Networks – Transport. [84] Within this framework, the **"motorways of the sea"** are envisioned as a complementary and alternative solution to road transport and two of the four EU corridors pass through Italy.

Between 2014 and 2018, CO_2 emissions from the Italian domestic and international maritime transportation raised by **29.8%**: the country is 5th in the EU for total carbon dioxide emissions, with a cumulated value of 11,028 thousand tons. [85]

The ranking elaborated by Transport & Environment [86] quantifies climate ambitions of the different EU Member States in efforts to decarbonize their shipping sectors. In this list Italy is third from bottom, followed only by Cyprus and Greece, showing too modest and unambitious targets. The most active countries in pushing for the creation of an effective climate plan that can be approved by IMO are Germany, Belgium and France. [87]

80 On 13th April 2018, IMO adopted the resolution MEPC.304(72), establishing to monitor and report fuel consumptions and emissions for all ships engaged in maritime transport from 1st January 2019, and to halve the pollutant emissions in the sector by 2050.

81 For example, the first prototype of the AI navigation system started operating on the Stena Scandinavica, under the tutelage of Captain Sjöström. A variety of different elements impacted on the ship and missing to considerate one of them was throwing off the navigation functions constantly. This first prototype did not include the wind and its importance in the navigation has been recognized only thanks to the collaboration with the Captain.

82 Centro Studi Srm – 6th Report of the Italian Maritime Economy, 2019.

83 SRM – 6th edition of the annual report "Italian Maritime Economy", 2019.

84 The Trans-European Networks – Transport (TEN-T) is a set of integrated transport infrastructures designed to support the single market.

85 Eurostat data, 2019.

86 In 2018, T&E has carried out research to rank EU member states in terms of the ambition of their declared national positions in the run-up to the IMO climate negotiations.

87 Transport & Environment – "Shipping Climate Ambition: Ranking of EU Member States", 2018.

Logistics ranks as the first maritime sector with 122,000 employees, playing a key role in the competitiveness of the logistics system: every year Italian ports handle almost 500 million tons of cargo. However, with respect to Germany, Italy still suffers a 18% gap in port services efficiency, 24% for the quality of roads, 40% for the efficiency of rail services and a 199% divide for ultra-fast internet line coverage. [88]

IMPACTS

Hitachi's technology:

- **Optimizes fuel consumption**, thanks to the AI selection of the optimal route to follow
- **Reduces sea and air pollution**, including CO_2 emissions linked to fuel consumption, NOX and other Greenhouse Gas Emissions. Moreover, the pollution deriving from the risk of ship grounding or sinking is avoided
- Decreases the **time needed to cross a route** improving the quality and timeliness of service for both passengers and freights, providing a key contribution to logistics
- Improves the travel experience and **the overall safety of the journey** suggesting the most opportune route based on the combination of multiple elements
- Through a **human-centric approach**, it supports captains and leverages on their unique knowledge to build up increasingly reliable and incrementally precise indications, also allowing for the training and support of less experience personnel

In a context in which the greenhouse gas emissions of the Italian maritime navigation are increasing (+29,8% between 2014 and 2018) the adoption of technology-based solutions is key to enable a **sustainable development** of the sector. Considering 2017 fuel consumption data and AI Captain's potential savings in terms of energy efficiency and CO_2 emissions, the application to the whole Italian navigation sector would reduce substantially the environmental impact of the sector. If today the maritime navigation accounts for 3.2% of total carbon dioxide emissions, the extension of AI Captain's target to all the sector would decrease this value of 0.1 percentage points. [89]

AI Capitan's target is to reduce fuel consumption by **2.5%** per nautical mile annually

This performance improvement would be equal to ~275,709 tons of CO_2 saved over the year, equal to 0.3% of the emissions of in the transport sector Italy in 2017 [90]

The sum of direct and indirect costs linked to CO_2 emissions saved thanks to a national scale adoption of Hitachi's technology would correspond to: **€7.3 million** of direct costs* and **€31.9 million** of indirect costs** for a total of **€39.2 million** of total costs avoided

* Direct costs of CO_2 resulting from the price of European Carbon Allowances trade on the EU ETS market.

** Social costs resulting from the negative externalities of CO_2 as decrease of the level of agricultural production, productivity of workers, increase in health costs, increase in expenditure for protection and restoration of the environment, etc. The value reported refers to the average between the conversion factors elaborated by EPA and Stanford University.

Key Takeaways:

In a context in which there is a shared global effort in pursuing a better and more sustainable future under the guidelines of the UN SDGs, technology represents the key driver in providing effective solutions to contain the emissions of shipping industry. The sector is also in search of solutions capable to improve the energy efficiency of its operations, to provide competitive gains of its players and generate concrete benefits for customers. Hitachi's solution, leveraging on extensive usage of A.I., machine learning and human to machine cooperation delivers the concrete results that the industry is looking for, contributing effectively to sustainability in a highly complex sector and linking the benefits of automation to positive social effects (man-machine collaboration, training, ...).

4.2.2 Digitization to improve the performances of electricity grid and enable the uptake of renewable sources: The Hitachi Special Protection Scheme

The global energy consumption is constantly rising and the optimization of the energy infrastructures and renewable sources' growth represent a cornerstone for reaching the sustainability of the system. National networks are scarcely equipped for this transition and require the application of new and innovative technologies.

88 Ufficio Studi CGIA Mestre elaboration on World Economic Forum data, 2019. The percentages are calculated on the basis of the scores recorded in the indicators of the Global Competitiveness Report 2018.

89 The calculation is based on the CO_2 emission factors from the transport sector identified by Ispra using the IPCC reference method.

90 Eurostat data, 2019.

HITACHI'S SOLUTION

Hitachi's Special Protection Scheme (SPS) is a fast and automatic Control Scheme designed to **mitigate power system disturbances** caused by the integration of renewable energy sources, such as high or low voltage, line overloads, unstable conditions and outages. This is a digital and advanced application to the traditional grid management processes. Differently from predefined offline-SPS systems, which have a seasonal or yearly frequency setting, Hitachi's Online-SPS **calculates the parameters in real-time** and has a frequency of control which spans between 30 seconds and 5 minutes.

Differently to traditional human-based systems, Hitachi's SPS has a much faster reaction time (which reaches even milliseconds) and provides an automatic response to fix the grid problematics and avoid wastes. Thanks to its distinctiveness, SPS permits to:

- Protect the power system and improve its reliability;
- Increase the average line power flow;
- Balance the loads and the generation of energy.

Additionally, with these swift and automatic responses, Hitachi's SPS provides grid operators with **enhanced flexibility** which permits to connect **more renewables** to the network, increase the transmission line capacity and simplify the grid management.

Energy systems differ country by country for their characteristics, issues and priorities, and the successful implementation of online SPSs require a **tailored technology**. Therefore, an approach based on **co-creation** between the solution provider and the client, the best actor to identify the necessities of its system, is key.

In cooperation with the clients, before installing the SPS, Hitachi proceeds with network analysis studies to **identify specific network issues** accurately and to tailor the SPS on the needs of the specific energy system.

As a result, Hitachi has been able to **install in heterogeneous territories high-quality SPS** which are having important economic, environmental and social impacts. Some examples are:

- The Chubu Electric Power Co., Inc. (CEPCO) – Japan
- The Bonneville Power Administration (BPA) – United States
- The Polskie Sieci Elektroenergetyczne S.A.(PSE) – Poland

THE ITALIAN SOCIAL NEEDS ADDRESSED

The **Italian energy intensity** [91] **is high** (the country's ratio between gross inland energy consumption and GDP was 85 in 2016, the European one 64) and the energetic system presents substantial **inefficiencies** (with 18.6 billion of KW dispersed, the Italian energy leaked for a 6.2%, whereas the Germans by 4.2% and the Spanish by 4.0%). [92]

Italian electricity **coverage stability** is decreasing. Indeed, between 2007 and 2017, the costumers' time lost due to long interruptions increased by 19.5 minutes. [93]

The increase of installed capacity from renewable sources is causing congestions in the Italian network up to the point that it is **necessary to reduce renewable production** (over-generation phenomenon). In 2020, the amount of the Italian **over-generation** is estimated to be **600 GW/year**. [94]

The **NIMBY** [95] phenomenon is on the rise in Italy as elsewhere, while soil consumption is also increasing. According to the 12th edition of the report published by Permanent Media Observatory of the NIMBY Forum, in Italy there are 317 infrastructures and plants subject to public dispute. The energetic sector leads the industrial rankings with a share of 57.4% of total contested constructions. Besides, while the Italian **urban concreting** increased in 2018 by 51 km^2, its population decreased by 100,000 inhabitants.

IMPACTS

Hitachi's technology:

- **Increases the connection capacity** of the network allowing a higher use of renewable sources, which require specific grid flexibility due to their instability;
- **Avoids the construction of new transmission lines** or encourage the creation of less invasive solutions, thanks to the greater power flow capacity;
- Secures a demand-supply balance, allowing a **more stable energy provision** to the communities;
- Minimizes the resources that have to be invested in transmission and distribution facilities, thanks to the increased total transfer capability of the existing transmission lines;

91 Energy intensity compares the consumption of energy with the source of its demand, it is calculated with the ratio between gross inland energy consumption and the GDP.
92 Eurostat data, 2019.
93 Arera data, 2019. Long interruptions are defined as a decrease in the voltage supply level to zero for more than 1 minute.
94 Terna data, 2019.
95 The NIMBY phenomenon (Not In My Back Yard) indicates a form of protest by a group of people or a local community against works and activities of public interest that could have negative effects of their territories. The Nimby Forum is active since 2004.

- **Reduces the generation curtailment** [96] amount by avoiding human over-reactions and, therefore, increase the power selling potential and the overall energy efficiency of the system.

Major quantitative impacts:

~2X grid's capability to support Renewables' inception. The system's capacity of sustaining renewable energy from wind farms, according to the feasibility study of Hitachi's SPS installation in Poland has doubled thanks to Hitachi's solution. Italy has a potential of more than 17 GW by 2030, but today is still under 10 GW installed. This is partly due to the necessity of upgrading its infrastructures, an element which Hitachi's SPS could contribute to solve and that would allow to unleash the full Italian wind energy generation potential.

+ 1,000 MW in terms of increased average line power flow of the Japanese CEPCO thanks to the Hitachi online SPS and - **1,000** MW, the reduction of the generator shedding amount in the American BPA site.

In the next years, the final energy consumption is expected to rise, given that by 2030 in a business-as-usual scenario it will reach up to 114.3 Mtep. [97] This requires a higher network capacity and lower inefficiencies, goals that Hitachi's solution can substantially help to achieve.

Key Takeaways:

Renewables are a clean and inexhaustible source of energy, crucial to reconcile growth and sustainability as foreseen by UN SDGs and Society 5.0 vision. National energetic systems, however, are still scarcely equipped to support similar sources of energy, characterized by frequent intermittences besides higher upfront costs, storage capabilities and geographic limitations. To maintain integrated energy grid stability and connect a high number of renewables, energy systems require superior levels of flexibility, which can be reached via the adoption of technologies as the one implemented by Hitachi with the Special Protection Scheme.

In Italy the implementation of a reliable, stable and efficient energetic system based on renewables is key to address in a sustainable way the increase in electricity demands from both households and businesses. The Italian National Energy Strategy (SEN) target is to achieve a share of renewables of at least 28% of final gross consumption by 2030. However, this goal is partly hindered by fragile infrastructures, with low levels of flexibility and significant energy leakages. New technologies enable to maximize the inherent potential in renewable sources through real-time monitoring and immediate and automated system reactions also rationalizing the existing Italian energy infrastructure, with low-impact and economically sustainable upgrades.

4.2.3 Cityringen: The Italian know-how and its contribution to make Copenhagen a Carbon Neutral Capital by 2025

In January 2011, Hitachi Rail won a European tender for the construction of the new metro of Copenhagen, called Cityringen and recently inaugurated (September 2019). Hitachi's solution presents highly innovative features which will contribute to reach Copenhagen's aim of becoming a Carbon Neutral Capital by 2025.

HITACHI'S SOLUTION AND KEY DISTINCTIVE FEATURES

Hitachi's solution is a **highly innovative and fully automated driverless metro**, with two tunnel lines of c.a. 24 km length each, 24 stations in total and 2 Control Centre Rooms. The driverless metro trains, signalling and turnkey systems are entirely produced in Italy.

The driverless metro guarantees a 24/7 continuity of service for more than 120 million passengers annually. With a station every 600 metres and a train every 100 seconds at peak hours (with around 34 trains running at full speed), the metro will serve 85% of the city's population, guaranteeing unprecedented capillarity and a fast and efficient transportation modality.

Thanks to forefront technologies and automation, it takes 24 minutes to go full circle, and since the metro

96 Generation curtailment is a reduction in the amount of energy delivered by a generator to the electrical grid and can happen when the transmission system is overloaded or under a situation of emergency. In this case, the grid operator may need to back down local generation to maintain system integrity.

97 The European House – Ambrosetti elaboration on Terna data, 2019.

trains run in both directions, the longest journey - between Copenhagen H and Skjolds Plads - is only 12 minutes (vs. c.a. 18.6 minutes estimated with the use of private transportation modalities).

Hitachi has built the Copenhagen Cityringen with the **highest standards in terms of safety, health and environmental protection**, as demonstrated by operative results and by the achieve-ment of the ISO 14001:2015 and OHSAS 18001 standards and the award of the Royal Smiley received in 2015, rewarding its high level of control (e.g. through accurate monthly controls of the incident frequency and the severity rate) and customer satisfaction. [98]

The project, a virtuous example of metropolitan infrastructure at European and global level, with its 24 new stations could double the number of passengers from about 65 million per year to 120 million. The Danish government is confident that the project will radically transform the appearance of the metropolitan area which, thanks to the integration of metro, S-Train bus (an innovative hybrid train for urban and suburban areas) and regional train services, will make it possible to reduce distances and encourage very low-consumption travel.

Together with innovative and state of the art technologies, the key and distinctive factor of the success of the project has also been the **constant involvement of the local community**, whose continuity was made possible by the provision of:

- Monthly meetings with a workgroup which comprehended the client, other contractors, employers and trade unions;
- The MSURR committee, composed by first aid personnel, the head of the local police and the Danish Emergency Management Agency, which was finalized in managing issues linked to the metro's operation and construction, such as evacuations and first aid.

Finally, during the construction works of the lines, Hitachi also placed special attention on mitigating the impacts on the **surrounding community**, for example limiting the worksite noise pollution.

THE ITALIAN SOCIAL NEEDS ADDRESSED

Italy presents severe problematics in terms of traffic congestion. Indeed, an Italian citizen loses on average 38 hours per year due to the road traffic (8 hours more than the EU average).

In 2017, 91% of the Italian passengers moved through road transportation and only 6% by rail. In this framework, however, 77% of the total demand concerns urban distances, below 10 km (with 35% below 2 km). [99]

The transportation sector is responsible for more than 34% CO_2 emissions in Italy (30% in EU) and, in 2018, 55 Italian provinces exceeded at least one of the permitted annual limits of 35 days for PM10 and 25 for the ozone. [100]

Despite private cars still account for a significant quota of the transport modality (52% in urban and 85% in extra-urban areas), in 2017 public transport raised its relevance achieving a quota of respectively 9% and 12%. [101]

In terms of metropolitan lines, Italy presents strong delays compared to the other European countries. The Italian metropolitan kms are 239.6 in total, distant from the UK (with more than 672 km), Germany (648.3) and Spain (609.7). Some of the European capitals, like London or Madrid, exceed alone the total km of metro throughout Italy.

Italy, however, also presents strong excellences in terms of technology and know-how. For example, Italy registered the highest rate of number of citations per researcher over the 1996-2017 decade, and is the 2nd country in the world for the value of its export in the "Machinery and Automation" category (2nd only to Germany). Even more, 4 of the top 10 European Provinces super specialized in manufacturing industry are Italian. [102]

However, the country presents strong criticalities in its internal division: in the last 16 years, 1.8 million of under-34 have left the South of Italy looking for a job elsewhere and only half of them have returned. [103]

98 The Royal Smiley is the maximum award which can be received along the assessment of health and safety compliance, assigned by the Danish authority for the working environment. Hitachi Rail team received the highest score in this assessment.

99 Isfort data, 2018.

100 Legambiente – Report "Mal'aria 2019", 2019.

101 The remaining part refers to non-motorized travel (active mobility by foot or bike).

102 According to Fondazione Edison and Confindustria elaboration on Istat data, 2018.

103 Svimez Report, 2018.

IMPACTS

Hitachi's technology:

- Enables to reduce the **congestion at stations** and in trains, guaranteeing a high-quality transportation system and adjusting train frequency according to real-time demand, ensuring a customer-centric and pleasant transport option;
- Allows to **decrease the greenhouse emissions**, by reducing the energy consumption via the optimisation of trains' frequency and the utilisation of more efficient vehicles. It also increases public transport services attractiveness and **encourages the utilization of cleaner solutions** with respect to highly-polluting transportation methodologies, such as automobiles (per passenger and km, on average a car pollutes more than 10 times than a metro), which would also cause significant socio-economic damages;
- Offers a high service level, guaranteeing a **24/7** transportation availability which ensures a flexible and citizen-oriented transport solution within the city;
- Contributes to the improvement of the **Italian economy** and the **employment** in the country, since its products are entirely realized in Italy and the Italian company is also responsible for the metro Operation & Maintenance (O&M) up to 2027;
- Increases, in terms of safety, the awareness for all workers with "near miss" [104] campaigns, as well as the number of inspections and involvement of the appropriate local authorities to receive competent advice on the project security.

The Cityringen provided an efficient and low-carbon transportation service to c.a. 85% of the population of Copenhagen.

~120 million passengers transported per year

In operation **24/7/365** with a frequency of **a train every 100 seconds** in peak hours

If these passengers would have been Italian commuters, taking the metro instead of their car would have saved per month:

~9,432 tons of CO_2, which correspond to **€248,344** of direct costs* and **€1,093,122** of indirect costs**

Therefore, the sum of direct and indirect costs linked to CO_2 emissions is **€1,341,466** of total costs avoided

* Direct costs of CO_2 resulting from the price of European Carbon Allowances trade on the EU ETS market.

** Social costs resulting from the negative externalities of CO_2 as decrease of the level of agricultural production, productivity of workers, increase in health costs, increase in expenditure for protection and restoration of the environment, etc. The value reported refers to the average between the conversion factors elaborated by EPA and Stanford University.

The project, since its products are entirely realized in Italy, also contributed to the Italian economy.

794,600 hours of works activated in Italy through Hitachi Rail

- that corresponds to more than **99,300 days** worked
- and the annual workload of **414 people**
- which corresponds to a cumulated value of **€12.03 million** gross salaries [105]
- that activate **€5.42 million** in consumption [106]

Finally, a similar technology applied to one of the most important Italian cities brought to a series of very significant impacts, such as the reduction of more than 8.4 tons of fuel and the avoidance of c.a. 260 accident per year. Additionally, the system allows to reduce staff costs, enforce high safety levels eliminating the human error, regulate the speed with respect to fixed limits.

Key Takeaways:

Hitachi is playing a pivotal role in shifting the mobility towards increasingly sustainable modalities. In the specific case of Copenhagen, the construction of the M3 driverless metro represents a further step in supporting the city's commitment of becoming carbon neutral by

104 A near miss is an unintentional incident that could have caused damage, injury or death but was narrowly avoided.

105 The European House – Ambrosetti elaboration on Istat data, 2019. The calculation is based on the median value of the gross pay per hour for dependent work position in the ATECO sector 30.

106 Considering a propensity to consume equals to 60%, net of taxes paid.

2025. The combination of flexible and safe solutions permits an improvement of the service effectiveness and efficiencies, therefore increasing the attractiveness of public transportation and guaranteeing a better users' experience. In a country, like Italy, where the majority of demand of transportation concerns distances below 10 km (thus within the usual urban perimeter), implementing similar solution would permit a shift in passengers' transportation modality from polluting private vehicles to greener and more sustainable solutions. Moreover, the existing technology enables the implementation of autonomous driving solutions. While automation in private transport is far from being deployed at systemic level and daily use, the current implementation in public transport demonstrates how innovation offers a concrete contribution to the Society 5.0, achieving socio-economic and environmental objectives also in Italian cities.

4.2.4 Hitachi's Optical Topography System to study human mind and associated diseases

Before the advent of Optical Topography, it was only possible to study the brain function of patients with neurological or psychiatric damage through invasive and restrictive techniques such as PET [107] or functional magnetic resonance imaging.

The optical diode system enables a more comfortable investigation of the state of brain activity, without exerting too many constraints on the subjects and with a spatial superior resolution.

HITACHI'S SOLUTION

While the National Healthcare Systems are principally relying on nuclear neuroimaging methods (due to a longer and stronger history of validation), there are many types of patients who cannot perform nuclear tests due to inherent limitations of the disease itself, such as neurological and psychiatric disorders characterized by tremors or hyperkinesis.

Moreover, the instrumentation for studying the human mind cannot be compared to an ultrasound machine because the organ under investigation is so complex that even today the laws governing its functioning are not known.

Within this context Optical Topography represent an effective solution for measurement which is non-invasive, and relatively restraint-free. **Advanced technology** and **enhanced operational features** make the ideal tool for monitoring cerebral blood flow. Hardware improvement and the adoption of data post-processing algorithms are two key elements to the development of this superior solution.

Hitachi's Optical Topography has been engineered for safe and user-friendly use in clinical and research environments.[108] Fields of application include: **brain mapping, cognition, psychiatric disorders** (depression, schizophrenia, dementia, ADHD, autism), **pediatrics** (development, language and skill acquisition, social skills, learning difficulties), **neurology** (pre-surgical mapping of the hemispheric dominance for language, detecting epileptic foci, stroke assessment and rehabilitation). In particular Optical Topography:

- Permits to find a **predictor of cognitive slowdown in older people**. By measuring brain activity, in fact, it is possible to say that the activity of some areas of the frontal cortex are more sensitive to physiological changes related to aging (as a person gets older he/she tends to respond more slowly to highly demanding cognitive tasks, and this is reflected in a hypoactivity of the frontal cortex).
- In the neurological field, **epilepsy** represents the ambit in which Optical Topography had the main developments and scientific results at the international level. With the simultaneous measurement of the electrical signal with EEG[109], the Optical Topography also allows to have a functional evaluation of the presence of an epileptic outbreak.
- Moreover, recent research has showed that the combined use with AI allows the identification of the **neurophysiological correlates** of specific social-behavioral phenomena.[110]

KEY DISTINCTIVE FEATURES

- Hitachi's product ETG-4100 uses near-infrared light of distinct wavelengths to measure changing concentrations of oxygenated and deoxygenated hemoglobin levels in the brain. The system software is

107 A positron emission tomography uses a radioactive drug (tracer) to show tissues and organs functioning.
108 The possible fields of application include cognitive neuroscience, psychology, psychiatry, neurology, rehabilitation, pediatrics and education.
109 Electroencephalography (EEG) is an electrophysiological monitoring method to record electrical activity of the brain.
110 A team of the Ibfm-Cnr centre of Catanzaro has recently showed that thanks to AI it has been possible to detect the personality profiles of gamblers and, through NIRS, it is possible to see what happens in their brain.

an **"all-in-one" solution**: from experimental design to measurement, from raw data to analysis, it combines all tools in a single suit.

- The great advantage of this method concerns the brain analysis of any activity that allows the **free exploration of environments**. Therefore, Optical Topography can measure one of the most important indicators of the clinical condition of the elderly: the path. This result will be used to establish the global parameters of use of NIRS (Near Infrared Spectroscopy) in locomotion studies.
- Hitachi's Optical Topography System is the result of **continued R&D in close cooperation** with researchers and clinicians to bring near-infrared spectroscopy to a new level.

THE ITALIAN SOCIAL NEEDS ADDRESSED

According to the WHO, mental disorders are destined to overcome cardiovascular diseases, currently the leading cause of mortality among noncommunicable diseases (NCD), and in Italy **17 million** people suffer from them. In Italy, dedicated spending corresponds to 3.5% of the total, a low percentage if com-pared to 10-15% of countries such us Germany, UK and France, a situation worsened by strong regional inequalities.[111]

Half of all mental illnesses begin at the age of 14, but in most cases are not detected or are underestimated. Depression is the most common mental illness among adolescents: globally, depressive or anxious forms affect **10%** of young people between the ages of 15 and 29.[112]

In our country 500.000 people suffer from epilepsy, **1 out of 100** [113], while the number of people diagnosed with dementia is about 1 million, of which 60-70% is represented by Alzheimer's patients. In 10 years (between 2005 and 2015), the number of people suffering from a form of dementia has increased from 7.5 to 15.6 per 1,000 inhabitants, while patients suffering from Alzheimer's disease have increased from 4.5 to 9.4 per 1,000 inhabitants.

The increase in cases of dementia is partly caused by the increase in the population over 65, which now represents 22.7% of the Italian population. It is estimated that in Italy, in 2015, there were about 951,000 patients with dementia over 65 years of age: in particular, more than **two thirds** of patients are over 80 years of age.[114]

While in some countries the Optical Topography has already entered into clinical practice, the adoption of Optical Topography in Italy is still hindered by **complex and multifactorial issues**:

- a general difficulty linked to the features of the brain, as a constantly and dynamically changing organ, necessity to invest on the hardware improvement,
- requirement of the adoption of new post-processing data algorithms, necessity of AI utilization.

The Ibfm-Cnr Centre of Catanzaro is one of the few research centers in Italy that has developed several AI algorithms for the automated diagnosis of data from nuclear neuroimaging. Only in this way Optical Topography will be finally able to enter the clinical field.

IMPACTS

Hitachi's technology:

- **NHS cost avoidance** by potential treatment cost savings thanks to early diagnosis and better support throughout the patients' journey (Optical Topography supports clinical trial);
- **Early detection of old-age diseases** in order to identify optimal therapies and to improve quality of live, cognitive and emotional wellbeing, since many treatments are more effective when administered early on in the disease;
- **Generates positive impacts on patients' clinical outcomes** which translates on improved quality life by minimizing disability, mitigating social-assistance national and private expenditure;
- **Its positive effects extend** on the patients' families, but also to the wider society and research community;
- **Maximises operational success** offering professional training (addressed to clients, physicians, other health professionals);
- **Fosters advancement of scientific research** to expand the treatment and care of targeted pathologies, via further clinical studies.

111 Italian Society of Psychiatric Epidemiology (SIEP) data, 2019.
112 World Health Organization data, 2019.
113 Italian League Against Epilepsy (LICE) data, 2019.
114 The European House – Ambrosetti – "XIII Rapporto Meridiano Sanità", 2018.

The implementation in the Japanese market has seen a rapid growth over the last five years:

~100 hospitals or medical entities are utilizing this technology for clinical purpose (**doubled** in the last 5 years)

>20,000 patients have been examined by this technology in the last 5 years (doubling in the same period)

The technology has already been applied for clinical purpose for the examination of:

- identifying language dominance area before brain surgery,
- identifying epilepsy focus area before brain surgery,
- differential diagnosis assistance for depressive symptoms.

Key Takeaways:
In a national context characterized by a growing public debt burden, the ongoing national demographic transformation may worsen the pressure on public resources, demanding for new goods and services. Indeed, hyper-aging has confronted Italian society with a plethora of challenges: institutions' goal is to solve the new critical issues while maintaining its system of high-quality healthcare.

Coherent with the Society 5.0 vision, healthcare aims to improve the healthy life expectancy and vitality of individual citizens, combining quality life with the overall society growth. In this context, diagnostics plays a fundamental role: tests with a high medical value allow the identification of the predisposition to a disease, the patient's response to therapies and the evolution of symptoms, giving the possibility to intervene in a targeted and timely manner, improving the cost-effectiveness ratio.

Optical Topography, currently being the only imaging method that allows us to see in vivo what happens in our brain while we walk freely in an open space, can play a key role in predicting symptoms of specific pathologies in older people, reducing diagnosis time and errors.

4.2.5 Innovating healthcare by embracing the future: The case of Particle Therapy

Globally, about 1 in 6 deaths is due to cancer: responsible for an estimated 9.6 million deaths in 2018, it is considered as the **second leading cause of death** behind cardiovascular diseases worldwide. [115]
The WHO estimates that between 30 and 50% of cancers can be prevented by avoiding risk factors and implementing existing evidence-based prevention strategies, on the other hand cancer burden can be reduced through early detection of cancer and effective treatments. Within this context, recent developments in personalized medicine and novel treatment approaches have raised hope of significantly improving cancer survival.

HITACHI'S SOLUTION

After years of research, a broad range of technical and clinical experience and collaborative work with **world-class hospitals** and **cancer centers**, Hitachi has become a reliable partner of the medical community for particle therapy, one of the most advanced forms of cancer therapy available, and a global leader in the provision of this healthcare advanced technology.

Within the particle therapy, the dose of radiation to **tumor masses** (including many rare tumors) is **maximized**, by contemporarily saving adjoining healthy tissues. This type of treatment is specifically indicated for treating tumors that have developed near critical organs or delicate structures like the brain, heart, head and neck, prostate or spinal cord. In Italy, a Ministry of Health decree has identified 10 clinical situations in which patients should be treated with heavy particles.

Compared to more common radio-therapies, proton therapy has several distinctive advantages. Firstly, short-term and long-term side effects from radiation to normal tissues and organs are reduced or avoided, allowing the patient to continue leading a normal life (absence of pain, lesser impact on body's normal functions). Specific clinical studies have shown how proton therapy decreases the risk of the occurrence of **secondary tumors**: the precision of proton beam therapy saves the healthy tissues resulting in a lower probability of secondary radiation-induced tumors or those that can occur even many years after radiation treatment.

115 World Health Organization data, 2019.

Secondly, proton therapy is a particularly useful treatment in the case of **childhood tumors**. Since a child's body is continuously growing, it is more sensitive to x-rays, more affected by their toxicity, and more prone to undesired side effects.

In addition, **a new solution** for the treatment of moving targets affected by respiration, such as those in the lung or liver, able to achieve high dose delivery while significantly minimizing exposure to healthy tissue and organs, has been developed by Hitachi.

KEY DISTINCTIVE FEATURES

- Hitachi's technical advantages are based on a superiorly precise beam control technology, resulting from a process of continual refinement of the electromagnet and synchrotron accelerator design.
- The particle therapy system has been **entirely designed in-house**, with all the technical solutions developed by Hitachi, including the accelerator, irradiation system, control system, imagining software and treatment planning system. Innovation and development are implemented together with customers: Hitachi involves its customers to design market-leading innovative technology in order to meet and satisfy operational and clinical needs, constantly engaged in the refinement of support services.
- Hitachi, through a cooperative approach, fosters medical scientific innovation implementing forms of collaboration with **research** and **academic centers**, as Hokkaido University [116] and the University of Texas MD Anderson Cancer Centre.
- The heart of a proton therapy center is the proton beam delivery system and the buildings, the premises, suitable for treatment with high-energy ionizing radiation. Hitachi's solution stands out from competitors for a **superior environmental performance**, endowed with a clean and efficient proton synchrotron and high energetic efficiency, demanding for lower power consumption and producing a limited amount of radioactive waste with no contamination. In particular, the reduction of radioactive waste produced determines a safer facility, in terms of operators and other patients' exposition to radiations, with no lasting impact on the building and the land.

THE ITALIAN SOCIAL NEEDS ADDRESSED

Every day, in Italy, about **1,000 people** receive a new diagnosis of malignant tumor: in 2018 were estimated new 373 thousand diagnoses. Almost 3.5 million Italians live after the diagnosis of cancer, a figure that is constantly growing (they were 2.244 million in 2006, 2.587 million in 2010, about 3 million in 2015), thanks to increasingly effective treatments and greater adherence to screening programs.[117] The economic burden of cancer is estimated at €16.5 billion.

In Italy there are about 160,000 patients who undergo radiotherapy every year and of these about **10%**, suffering from tumors placed in difficult places (near organs at risk), would benefit more if treated with Hadron therapy.

Recognizing the benefits of this therapy and its current clinical applications, in 2017 cancer treatment via proton therapy has been **included** by the Italian Minister of Health **in the LEA** (Essential Levels of Care), the services that the National Health Service is required to provide to all citizens, free of charge or against payment of a ticket, with public resources. [118]

Proton therapy has been available in Italy since 2011 and even if the number of particle therapy centers is increasing, they are still not sufficient to respond to **actual social needs**. Today the existing proton therapy centers are: CNAO Foundation in Pavia and the recently opened Proton Therapy Centre in Trento (APSS). To these add the Ocular Hadron therapy Centre in Catania (Càtana).

IEO Proton Centre, the first IRCCS (Scientific Institute of Hospitalization and Treatment) to offer cancer patients the most advanced method of high-precision radiotherapy available today, will be operational in 2021 and will be able to treat up to 800 new patients per year.

Annually, considering the cases of epidemiology codified in the LEA framework for proton treatment, the number of potential patients ranges between 4,000 and 5,000, while subjects eligible for carbon ion therapy alone are c.a. 1,000. In our country, even under conservative assumptions, every year only the **~30% of all potential patients** are treated, a number that highlights the presence of a significant unmet need and

116 The scanning and tracking technology have been implemented in collaboration with Hokkaido University.
117 IACR - Italian Association of Cancer Registries (AIRTUM) – Annual Report "I numeri del cancro in Italia 2019", 2019.
118 CNAO, 2017.

a wide gap in the health system. As a consequence, hundreds of Italian patients every year move to other EU countries to receive proton therapy medical treatment.

IMPACTS

Hitachi's solution enhances proton therapy's advantages:

- **Reduces toxic and adverse effects** with respect to radiation therapy with x-rays, especially in case of childhood tumours, decreases the risk of growth defects and developmental problems along with the occurrence of secondary tumors, saving the healthy tissues adjacent to the part of the body in which the tumor developed;
- **Generates positive impacts on patients' clinical outcomes** which translates on improved quality of life following cancer treatment, reduced losses in individual utility or social welfare, National Health System's expenditure restraint;
- **Improves** the positive advantages of a non-invasive **treatment experience**, reducing sessions' length;
- **Increases treatment's accessibility**, as the adoption of this technology would reduce flows of passive cross border health mobility, as well as the extra-costs related;
- **Does not require degrader** for energy changes, enabling better maintenance ability thanks to immediate access to the system for urgent interventions;
- **Improves environmental performances** thanks to low power consumption (lowering operational utility costs), less shield, decreased radioactive waste production and no contamination, facilitating end-of-life management and causing no lasting impact on the land;
- **Maximises operational success** offering dedicated customer training (addressed to clients, physicians, other health professionals) delivered by expert staff;
- **Fosters advancement of scientific research** to expand the treatment and care of cancers, via further clinical studies.

>65,000 global patients treated by Hitachi's particle therapy system

75% of all patients treated with carbon-ion therapy worldwide have done it through Hitachi's technology

19 facilities in Japan and other
12 facilities overseas

-50%, reduction of the radiation shield length

Radioactive waste production represents **~1/10** of average particle therapy solutions'

In December 2019, following a comprehensive public tender process, **Hitachi has been selected to provide Centro Nazionale di Adroterapia Oncologica (CNAO) with its proton therapy system**. CNAO was established and is operated by the CNAO Foundation, a non-profit organization fully funded by Italian government: today it represents a worldwide excellence in cancer treatment. Equipped with the latest technologies, this will be the first Hitachi proton therapy system to be installed in Italy and the second in Europe.

Key Takeaways:
Today, the National Health System has to face a complex scenario, characterized by major demographic, epidemiological and socio-economic changes, with critical issues to be managed as the progressive aging of the population and the increase in chronic diseases. The latter, in particular, represent high-impact pathologies, more responsible for the loss of years of life lived in good health. Among the diseases with a high socio-economic impact are cancers: the number of people affected, deaths, relapses for the families of the sick and impacts on health and social care systems place these diseases among the public health priorities of governments at the global level.

The provision of effective cancer treatment solutions, as the proton therapy one, addresses not only a large share of unmet needs across the entire population but also specific issues linked to the oldest population group, the share presenting the higher vulnerability to tumors. It is worth mentioning that, according to the Italian Foundation for Cancer Research (AIRC), in Italy 64% of new cases of cancer that occur every year affect people over 65 years of age.

Within this context, Hitachi plays a key role in refining the technology and expanding its accessibility to more cancer patients, leveraging on years of research and development, a broad range of technical and clinical experience and collaboration with world-class hospitals and cancer centers.

4.2.6 The world's largest commercial electric vehicle dataset: The case of Optimise Prime as a key contributor to the systemic transition in the mobility paradigm

The necessity to combine the growing energy demand with a lower environmental impact requires a strong capacity to innovate and the ability to identify efficient solutions, characterized by a lower impact, especially in those sectors that today have the most significant effect on the emission of pollutants and the consumption of fossil fuels.

The transport sector, in particular, is today among those with the greatest need for renewal. In this sense, the electric mobility revolution promises to respond concretely and shortly to the ever-increasing demand for mobility and transport, combining it with solutions capable of enabling sustainable growth. In order for this revolution to produce its positive effects at a systemic level, however, it is necessary to proceed with an overall adaptation of existing infrastructures - acquiring a greater understanding of the implications and the associated impacts and adopting interventions and corrective measures that are able to limit the negative repercussions associated with changes in consumption habits and related use -.

The shift from internal combustion vehicles to the electric mobility paradigm will have a profound impact on urban planning and infrastructure modernization. For example, while until a few years ago the refueling and parking of vehicles were separate elements, today the charging infrastructure needs to be integrated with the parking areas. Besides, the electrical infrastructure is in danger of facing unprecedented stress.

In this context, the availability of large amounts of data - generated by vehicles, charging stations and smart meters integrated into the network - becomes a strategic resource for infrastructural and urban design, so as to meet the needs of users and enable more sustainable forms of mobility and transport.

HITACHI'S SOLUTION

Launched in UK at the beginning of 2019, the project aims to be the largest commercial EV [119] innovation project to date with the goal to collect and analyse data from 2-3.000 electric vehicles of the country, creating a dataset that can be used by the electricity networks to plan their future investments to meet the growth in demand from electric vehicles.

The technological solutions proposed by Hitachi for the collection, analysis and modelling of fleet and EVs and PHEVs [120] journey data target the need of a better understanding of the impacts on the network caused by the forecasted increase of electric commercial vehicles, in particular to:

- separate the electricity demand of commercial and domestic vehicles, thus facilitating the quantification of their presence and the estimation of the flexibility in their charging need;
- develop solutions to optimize the supply of energy in the depots and domestic charging stations.

UK Power Networks, primary interlocutor of the project, is interested in delivering a flexible, reliable and low-cost electricity network, well aware of the challenges of decarbonising Britain.

- **Large-scale field trials** allow the collection of significant values of real data to understand the variations between fleet and vehicle types linked to the emerging demand of commercial EVs. Data collected during the second phase of the project [121] are analyzed and elaborated in order to **improve planning tools** and **enhance smart charging**, providing useful insights to optimize the utilization of the infrastructure.
- Technology represents the key enabler for the effective and valuable **management of massive data volumes** to enhance sustainable mobility. The creation of data sets detailing the usage and charging behavior of a large sample group of commercial vehicles to support a wide range of stakeholders to effectively plan infrastructure for the future requires reliable and timeliness processes to acquire, validate, store and protect this precious resource.

119 Electric Vehicles.

120 Plug-In Hybrid Electric Vehicles.

121 Following an initial phase of design and build, the second phase tests vehicles on the road. Test area include a range of urban, suburban and rural scenarios across the South East, South Central and East of England.

- The successful implementation of the project asked for a **collaborative effort among a multiplicity of institutional and business actors**, as the UK energy regulator Ofgem, Hitachi, Royal Mail and Uber. Within this context, Hitachi Vantara is the responsible for designing and operating the IoT platform.

THE ITALIAN SOCIAL NEEDS ADDRESSED

In 2018, **half of Italian provincial capitals** exceeded at least one of the two limits for fine particulate matter (35 days) and ozone (25).

Pollution represents a serious threat to human health: the number of Italian deaths linked to air pollution is particularly relevant: in 2015, of the 422,000 premature deaths in Europe due to air pollution, **60,600** were Italian. Road transport contributes greatly to this problem: it accounts for almost 20% of primary emissions of PM10 and more than 50% of nitrogen oxides (NOx).[122]

The electric vehicles' market is still underdeveloped in Italy. In our country, electric vehicles (passenger cars, light commercial vehicles and heavy-duty vehicles) amount to **0.1%** of total vehicles in circulation. Today there are only 28,498 electric vehicles, but the number has increased on average by 54.3% per year from 2014.[123]

To meet the policy target set by the Italian PNEC [124], electric cars sold [125] have to increase significantly over the next years. To reach the 2030 target, **41,805** additional electric cars are needed while about only 15,000 vehicles are expected be sold in 2019.[126]

To support the development of electric mobility in the country, one of the key elements is the development of a charging infrastructure adequate to support the expected growth of electric vehicles in the next years. To achieve this goal, in Italy would be necessary **35 time more charging points** than the installed ones. Furthermore, the empowerment of infrastructure networks needs to go in hand to hand with renewable share growth in Italian electricity generation to enable the transport emissions' reduction set by PNEC.

The Italian **energy intensity** [127] **is high** (the country's ratio between gross inland energy consumption and GDP was 85 in 2016, the European one 64) and the energetic system suffers from substantial **inefficiencies** (with 18.6 billion of KW dispersed, the Italian energy leaked for a 6.2%, whereas the Germans by 4.2% and the Spanish by 4.0%) [128] and decreasing **coverage stability**.

IMPACTS

The main goal of the project is to win the actual network criticalities to **unlock a large-scale transition to electric of commercial vehicles**. In particular Optimise Prime can help to:

- **Generate a deeper understanding** of the impact of commercial EVs and the opportunities for flexibility to share with the Distribution Network Operators (DNOs);
- **Accelerate (or remove barriers to) a cost-effective adoption of electric vehicles** minimising the environmental impacts of a carbon mobility system, in terms of CO_2 emissions, improved air quality, noise pollution, higher levels of energy efficiency;
- **Create a data set** detailing the usage and charging behaviour of a large sample group of commercial vehicles that can be used by a wide range of stakeholders to effectively plan infrastructure for the future and explore opportunities for optimising the network (e.g. with new services) and charging infrastructure;
- **Test technical and commercial solutions** to reduce the cost of the transition to citizens who have to pay for the electricity network through their power bills;
- **Foster solutions' sharing** and stimulate key learning among other electricity networks, raising awareness on sustainability in lifestyles and industrial processes.

122 In 96 out of 120 cities.
123 The European House – Ambrosetti elaboration on European Automobile Manufacturers' Association (ACEA) and European Alternative fuels observatory (EAFO) data, 2019.
124 The National Energy and Climate Plan.
125 The number of electric cars in the Italia stock considered in the PNEC are only Battery Electric Vehicles (BEV) and Plug-in Hybrid Electric Vehicles (PHEV) while traditional hybrid (full-hybrid and mild hybrid – HEV) are excluded.
126 The European House – Ambrosetti elaboration on Electrify 2030 research by The European House - Ambrosetti, 2019.
127 Energy intensity compares the consumption of energy with the source of its demand, it is calculated with the ratio between gross inland energy consumption and the GDP.
128 Eurostat data, 2019.

If the project methods are successful and implemented throughout Great Britain, there will be significant **environmental, economic and social benefits**:

-2.7 million tons of CO_2 across UK by 2030

which correspond to: **€71 million** of direct costs* and a range between **€90 million** and **€532 million** of indirect costs avoided **

Increase of electrification of depot-based fleets due to cost savings to the connected customers by **36%** by 2030

Total savings of **€230 million** by 2030

* Direct costs of CO_2 resulting from the price of European Carbon Allowances trade on the EU ETS market.

** Social costs resulting from the negative externalities of CO_2 as decrease of the level of agricultural production, productivity of workers, increase in health costs, increase in expenditure for protection and restoration of the environment, etc. The value reported refers to the average between the conversion factors elaborated by EPA and Stanford University.

Key Takeaways:
Electrification of individual and collective transport is today both a priority and an opportunity: according to three alternative scenarios relating to the penetration rate of electric mobility in Italy by 2030, turnover and the value chain in the country could increase in the near future reaching an estimated value between €102.5 and €456.5 million by 2030.[129]

Collaboration between stakeholders is key to the widespread adoption of this technology: Electricity Networks and operators of electric vehicles must share data in order to allow for efficient system design and operation that creates benefits for all parties. Indeed, the provision of sufficient power infrastructure to enable the timely transition to ultra-low carbon vehicles needs to go hand in hand with city management, while leveraging on the virtuous relationship between the electric carrier and digitalization. Digital technologies, in fact, enable better data management, providing predictive maintenance and better planning and operational changes, while boosting the connectivity in the overall energy system.

4.2.7 The Green future of Data Economy: The case of Aruba Data Centre

FIAMM Energy Technology SpA, an Hitachi Group Company which develops mobility and reserve power products, has realized a solution based on batteries - compactable and with a high storage capacity – capable to support the energy needs of Data Centers, which require an abundant provision of energy that also has to be stable, secure, reliable and easily adaptable to clients' demand.

HITACHI'S SOLUTION

FIAMM, in partnership with Aruba - the leading company in Italy for multiple internet services, including data centers (over 2 million domains, 7 million email accounts and around 5 million customers) - and the **local community and institutions** has contributed to realize a Data Centre capable of outperforming the market in terms of reliability, quality of the service and minimized environmental impact. Indeed, FIAMM has provided particular batteries able to sustain Aruba's data center power provision, guarantee a stable and reliable source of energy and compensate for the instability of renewables.

Thanks to the features of its solutions and to a co-creation approach capable of analyzing and solving partners' needs, FIAMM has been able to address Aruba requests for a particular tailored solution capable of storing renewable energy and optimizing the space, since Aruba:

- wanted to utilize renewable energy produced with a photovoltaic system installed on the plant and a nearby hydroelectric dam;
- planned the Data Center to be powered at 100% by renewable energy, as all its centers;
- needed an absolutely reliable system with no network interruptions also in cases of outages;
- aimed to optimize at maximum the space of the Data Center, which has been created within an abandoned textile industrial area in Ponte San Pietro (BG).

129 The European House – Ambrosetti elaboration on Electrify 2030 research by The European House - Ambrosetti, 2019.

KEY DISTINCTIVE FEATURES

The innovative element of this solution lies in the provision of a modular and flexible construction of the UPS-Batteries power system. The long-life batteries, which require no maintenance, are installed in mobile containers that can be moved and reconnected according to energy requirements and are able to store enough renewable energy to guarantee maximum power reliability of the system, at the same time **optimizing energy and space usage.**

This solution is also in line with the necessity of Aruba of having high flexibility to adapt the investments to customers' demand. Indeed, this technology has a distinctive **modular design** which can be easily scaled. This collaboration enabled the creation of a completely green and innovative solution to power the biggest Italian Data Centre Campus with 100% renewable energy. In this framework, the batteries ensure the system the maximum stability achievable and the highest level of security, all day long.

THE ITALIAN SOCIAL NEEDS ADDRESSED

Data Centres, thanks to their data storage function, are the **enabler of the digital economy**, an increasingly important sector, considering that in 2016 Italian data professionals were **472,000**, 2.3% of the total Italian employment (forecasted to grow, with a baseline scenario estimation, to 649,000 in 2020) and that the value of the whole Italian data market was c.a. **€4.6 billion**, grew by 1.5% respect to 2017 and its total impacts as a percentage of GDP is more than **1.5%**.[130]

The 11,000 Data Centers used by over 20,000 public administrations in Italy are most of times **small in size and not completely secure**. The management of these centers alone affects approximately **€2 billion a year**, more than one third of the public annual expenditure on ICT.[131]

Data centers use about 200 terawatt-hours (TWh) per year just in the United States, the energy produced by more than 30 large 500-megawatt coal-fired power plants and also account for c.a. 0.3% of total car-bon emissions, while the information and communication technology ecosystem as a whole - with a broad definition that includes personal digital devices, mobile phone networks and televisions - accounts for more than 2% of total emissions.

Moreover, considering energy consumption, researchers have predicted that within 10 years **3.5% of global emissions** could come from internet-connected devices. At the moment, Data Centers' emissions are equivalent to the whole aviation industry and every single research on a search engine generates circa 10 grams of CO_2.

By 2030, the use of electricity in data centres will increase of about 15 times, reaching up to 8% of the expected global demand in a context in which the Italian share of **renewable energy** sources in the total final energy consumption (16.1% in 2017) is below the Southern Europe average (18.3%) and far from the Northern Europe one (25.7%). Availability of effective storage solutions is among the key issues the industry must solve.[132]

IMPACTS

Hitachi's technology:

- Permits to utilise an elevated level of **renewable energy**, which is usually highly instable (up to 100% in the case study analysed);
- Enables to manage the **energy provision** of a company via own renewable sources (e.g. solar panels) and having, at the same time, an absolutely reliable system stability;
- Allows to optimize the space which is utilised in a plant for the facilities related to the energy provision, allowing **maximum flexibility** (including the possibility to contribute to spaces' regeneration), contributing to solve space issues and enabling future scalability;
- Remotely monitored 24/7/365, the batteries support a stable connection and data safety for the users. Therefore, it improves the development of the Italian **Data Economy** without harming the environment and the surrounding community;
- Enables the development of the Italian Data Economy without damaging the environment and the community, yet contributing to their needs and triggering a virtuous development which combines sustainable growth and economic growth.

130 IDC data, 2017.
131 Consip and Sirmi data, 2019. The digital transformation team of the Italian government is currently engaged in reducing the number of Data Centers to 7, to significantly reduce the costs coming from the management of digital services of the Italian public administration.
132 Eurostat data, 2019.

+30% energy density vs. average traditional batteries, higher than 100kWh/sqm

-30% of **space usage** thanks to batteries' frontal connections and their energy density

As in the case of Ponte San Pietro, the particular flexibility of this compact technology also enables to utilize – thus regenerate - abandoned urban areas

24/7/365 remotely controlled batteries allow to reduce disruptions and improve energy stability

~70 tons of CO_2 saved every year through:

- **100%** renewable energy supply
- **Up to 90MW** self-produced hydroelectric and photovoltaic energy

~500 workplaces created
Equal to c.a. 5% of the employment in the ICT sector in the Province of Bergamo

Key Takeaways:
As the world becomes increasingly digitalised, Data Centres' energy-intensive power requirements have to face a limited availability of space and electricity, critically hinging on the pace of efficiency improvements. In July 2019 the Municipality of Amsterdam, Europe's largest Data Centre hub, had to pause new centres building exactly due to these problematics and to establish a guided and sustainable growth path for the sector.[133] Energy stability, efficiency and usage of low-impact resources is key to match the economic growth allowed by data economy and the sustainable growth envisioned, among the others, by SDGs.

A technology such the one of FIAMM allows Italy to advance towards a proper Society 5.0, where innovation players provide solutions, developed together with other stakeholders of the society, to address social needs (employment, urban spaces regeneration, environmental protection, economic growth, etc.) and put the country on the right course for an economic, social and environmental sustainability.

4.2.8 The Green future of Data Economy: The case of Aruba Data Centre

The Membrane Bio Reactor (MBR) case, co-implemented by Hitachi with Madel SpA, one of the most important Italian chemical companies in the home cleaning and body care manufacturing sector, is a note-worthy example of the positive impacts deriving from circular economy's implementation. In line with the Society 5.0 goals, this case allowed to **turn waste into new products:** closing the materials' cycle, it enabled to use the company's wastewater to create new products.

HITACHI'S SOLUTION AND KEY DISTINCTIVE FEATURES

The MBR has been implemented in the production process of Madel's plant through Hitachi's distinctive **cooperative and collaborative approach**. Indeed, Hitachi's **H-Vision** model goes beyond the simple energy audit: it produces data which individuate waste and inefficiencies but also propose innovative solutions and actions. In this context Hitachi shared with Madel its commitment in developing new solutions which can positively impact on the surrounding community.

Thanks to this co-creation approach Hitachi has been able to deal with the energy efficiency needs of Madel, applying MBR technologies, which represents an innovative solution to the problem of **optimization of the wastewater treatment**, creating an ad-hoc solution capable not only of reducing energy consumption, but also of improving the environmental performance and the sustainability in the management of water cycle.

The circular water treatment ideated by Hitachi Drives & Automation combines a **membrane for the ultra / micro filtration process** and an activated sludge one, a technology that permits to:

- reduce considerably the wastewater that reaches the drainage system and improve water sewage quality,
- retain elements which can be utilized to create new products for the market,
- reinsert in the production cycle a significant amount of the former wastewater.

133 Announced in July 2019, Amsterdam data center pause could end by mid-2020 (source: http://www.datacenterdynamics.com, accessed 15th September, 2019).

THE ITALIAN SOCIAL NEEDS ADDRESSED

Italy is the country which uses the highest quantity of water across the EU. In fact, the Italian water withdrawals per inhabitants for drinking use are **160 m3/ year** (vs. EU average of 78 m3). The industrial sector is responsible for **21% of the total consumption** of the water resource (agriculture for 51% and the civil sector for 20%).

Italy has a **low rate of safely treated** wastewater flows (from households and industry) discharged into water bodies: 88.4%, vs. 98.2% in Germany, 94.4% in the UK and 90.1% in Spain.[134]

In 2016, Italy was the EU country that produced the **largest volume** of hazardous industrial waste sludge (738 thousand tons vs. 443 in Germany, 164 UK and 163 in France), as well as the **third in Europe** for the production of sludge and hazardous liquid waste from wastewater treatment.[135]

To solve the criticalities weighting on the Italian water system, an investment of €65 billion would be necessary from now to the next 30 years, equals to an annual expenditure of about **€40 per inhabitant**. Today these investments stop at €26 inhabitant/year, one third of UK and US values.[136]

IMPACTS

The use of Hitachi's Membrane Bio Reactor:

- **Diminishes wastewater's quantity** intended to sewerage and improve its final quality;
- Decreases Madel's costs in terms of **lower fees associated with the wastewater**;
- **Limits environmental impacts** and contain economic costs related to water procurement, since a considerable part of the former wastewater can now be reintroduced in the production cycle;
- Increases circularity and potential revenues, since part of the **former wastewater can now be utilised for new products** on the market (car shampoo, floor detergents, etc.);
- **Improves overall energy efficiency**, reducing environmental impacts and economic costs associated with a lower number of hours of electric pump's use;[137]
- Moreover, the presence of a firm that is attentive and committed to reducing pollution **generates a social impact over the local community life quality** (e.g. in terms of pollution's indirect costs).

91.7% reduction of surfactants in wastewater, which brought to water quality improvement entailing:

- reduced eutrophication of rivers, which is the enrichment of water by nutrients salts causing structural changes to the ecosystem
- a reduction of groundwater contamination
- a reduction of aquatic organisms' disturbance (detergents affect the natural defenses of these organisms)

Bringing to a -81.6% reduction of the total amount paid as sewerage fee within the Italian context

The high potential of this model lies in the possible application to all the medium and small-sized plants which aim to reduce their waste of water. Assuming that all the Italian companies active in the chemical sector manufacturing soaps and detergents, perfume and cosmetic, cleaning and polishing preparations adopt the same level of optimization of wastewater treatment as Madel, there would be:

~€25,700,000 total savings/year [136]

Key Takeaways:
Today water is becoming a less abundant commodity due to droughts, overuse and losses through leaks. In order to deal with this issue, it is important to implement effective and efficient water resource management systems. Within this context chemical pollution is one of the main pressures affecting the status of 18% of surface water bodies in the EU.

134 UNStats data, 2019. Among the objectives set by the United Nations is to halve the value of this indicator.
135 With 158 thousand tons (after Germany and France). Eurostat data, 2019.
136 OECD and World Water Council data, 2019.
137 At the end of each production cycle, during the washing phase of the tanks, the company uses a significant volume of well water for rinsing. Water comes from the pumping of wells through electric pumps. Water reuse permits to limit the necessity of pumps, and as a consequence the costs linked to their functioning.
138 The European House – Ambrosetti elaboration on Hitachi and AIDA data, 2019.

Despite a growing understanding of the importance of sustainability, it is not always easy for companies to adopt the best solutions capable to effectively address water consumption and pollution issues, nor to understand the value associated to a virtuous management of their water usage.

For this reason, Hitachi's innovative approach, capable to associate sustainable growth to economic benefits and to deliver energy efficiency, lower costs, waste products' reuse and circularity, provides an extremely valuable contribution. This goes beyond technological improvements, encompassing a radical change in mentality and approaches by the private sector. It is triggered by distinctive know-how and a co-creation approach, capable of understanding partners' needs and delivering the best.

4.2.9 One ticket, many services: The Smart Ticketing solution for Trentino Trasporti

Nowadays, transport systems face many unprecedented challenges. Among the others, the idea of a Single European Transport Area, promoted in 2011 by the European Commission in its White Paper for Transport, sets major goals to be achieved by the sector by 2050.[139] Within this time horizon, EU transportation has to become more competitive and resource efficient, leveraging on the opportunities opened by digitalization.

In this framework, under the push for innovation, ticketing systems are progressively evolving. While only a few years ago the main goal of ticketing systems was to, firstly, organize the collection of public transport fares and, secondly, to control and reduce fraud on the public transport network, the arrival of Intelligent Transport Systems is transforming the role of ticketing. Smart Ticketing is not necessarily about having one ticket for one journey, but a single wallet for multiple tickets or even one wallet for several different types of transport services. This allows to incorporate important statistical functions that, whilst respecting the privacy rights of passengers, permits the operator to track and better understand their patterns of use.

HITACHI'S SOLUTION

The propensity towards an active presence in local communities and the commitment on the SDGs are deeply embedded in the **Hitachi Rail STS's case.**[140] The company, which is among the 18 founders of the Global Compact Network Italy, has proposed to **Trentino Trasporti** Authority a radical change to the existing ticketing system with the aim of transforming the traditional model for transportation to MaaS (Mobility as a Service), supported by Hitachi technologies.

The new digital ticketing solution leverages Hitachi group's experience of ticketing solutions and digital technology and is designed to use **smartphones** as tickets. This innovation can improve the travel experience of passengers, enabling them to enjoy more comfortable end-to-end journeys without relying on a paper ticket or smart card validators. At the same time, the solution helps the operator to reduce investment and maintenance costs for ticket vending machines or validators, and generates a positive impact on the environment by reducing paper consumption.

To maximize performance in the actual site and offer a solution tailored on specific local needs, the system is tested in terms of: **response time** to passenger actions through actual journey experience, **sustainability** against severe communication conditions especially in mountainous areas, **and acceptability** by actual user experience.

Compared to competitor systems, Hitachi has developed a solution that is cost efficient (in terms of initial costs and maintenance expenditures), easy to use and run, and scalable (the capability to expand to additional services and encompass areas of use **beyond transportation**).

KEY DISTINCTIVE FEATURES

The value added of the solution comes from the integration of the highly technological service in a wider system including other rail domain facilities, such as fleet operations and railway signaling service.

- Hitachi's technologies enable high volumes of cloud stored data management and live data measurement

139 The European Commission "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system" describes 40 concrete initiatives for the next decade to build a competitive transport system that will increase mobility, remove major barriers in key areas and fuel growth and employment. At the same time, the proposals will dramatically reduce Europe's dependence on imported oil and cut carbon emissions in transport by 60% by 2050.

140 In 2018, Hitachi Rail STS has confirmed its participation in the Global Compact, the voluntary initiative launched by the UN to promote a culture of respect for human rights, labor, the environment and the fight against corruption.

on site through sensors. The efficient collection of current traffic conditions and passenger flows is functional to the optimization of rail traffic and to the provision of information services (about climate and dangerous/extreme events), also allowing to safeguard passengers' privacy and respecting maximum standards of data protection

A collaborative co-creation process, side by side with the local population, provides for a tailor-made service, finely tuned to local needs.

- Passengers are involved at an initial phase to clarify their needs through interviews and in-depth studies, followed by the testing and development phase, in order to evaluate their level of acceptance, experience and confidence in the service.
- Involving wider local stakeholders, such as hotels, means the platform can integrate new business partners, increasing value for its users (creating customer-centric businesses in the value chain) and the city.

THE ITALIAN SOCIAL NEEDS ADDRESSED

Daily demand for mobility in Italy has rapidly grown in the recent years[141], increasingly centered around **large urban areas**.

Intermodal transportation [142] has increased from 3.8% in 2008 to **4.6%** in 2016, achieving a better, smarter and more rational organization of transport.

In 2017 transport mixes made by private means of transport accounted for just 1.9% of total **intermodal solutions**, while combinations among public modes accounted for 21.1%. Combinations among private and public means represented the preferred choice, with a share of 71.1%.[143]

Our country has a great potential for mobile ticketing. According to a 2018 research by GoEuro, Italy is the **first market** in Europe for mobile bookings: 79% of the total.[144] According to the study, 82% of air tickets, 78.7% of bus tickets and 77.3% of train tickets are purchased via mobile.

However, the false belief that train tickets must be printed in order to be valid is deeply rooted: according to the GoEuro research, **81%** of Italian respondents prefer self-service machines or ticket offices for buying tickets, while 40% of those who had purchased online later printed a paper version of the ticket.

Key Takeaways:
Smart technologies and Intelligent Transport Systems (ITS) have a role to play in allowing Italy to face the challenges of its transportation infrastructures. Digitalization can significantly contribute to a cleaner, safer and more efficient transport system, especially in urban areas.

Smart Ticketing solutions offer a key contribution to the development of more sustainable mobility systems, proposing complementary services to users, in relation to their mobility – encouraging intermodality and simplifying the use of public transport – or with a wider global multiservice approach. Moreover, by enhancing security of the processes and reducing fraud improves the overall efficiency (and image) of the public transport network and the depth and the quality of the data created during usage.

Smart Ticketing will enable an overall improvement to the public transport network's level of services, image and accessibility. Its main aim is to facilitate and increase the use of public transport and so contribute to the overall goal of developing a sustainable transport policy.

" Remove all assets and supply a flexible, modern, simple way for passengers to enjoy the mobility services."

4.2.10 A Society 5.0 paradigmatic case: IoTrain as an example of digi-circularity changing both manufacturing and mobility

Hitachi Rail SpA is a rail transport engineering companythat has a wide array of products, which range from high-speed trains to driverless metro. In this sector, Hitachi develops innovative technologies based on data, automation and a customer-centric approach.

141 National daily mobility rate in 2017 was 88.5%, 5 p.p. higher vs. 2012.
142 Defined as the combination of different modes of transport in a seamless passenger travel experience or freight transportation.
143 The European House – Ambrosetti elaboration on Isfort data, 2019.
144 Data refers to the first half of 2018.

Doing so, Hitachi is also creating new business opportunities, advancing new manufacturing processes and organizational models and ensuring sustainable production and growth.

The IoTrain **case study** highlights such an approach to innovation and is emblematic of the whole concept of Society 5.0, where private actors in the sector of technology and innovation are enabling economic, social and environmentally-friend growth addressing the social issues that exist within Italian society.

HITACHI'S SOLUTION

Hitachi applies its vision of economic, social and environmental sustainability to hi-tech manufacturing, by realizing a smart factory (the so-called **Digital Factory**) capable of improving work and value-added creation and reducing the impacts on the environment thanks to advanced technologies and models. The output of such manufacture are innovative products, that are not only at the edge of innovation and competitiveness, but are also clean, capable of putting customers' needs at the core and incentivize sustainable mobility at systemic scale: the so-called **Train of the Future**. This is realized through a model that matches technology and sustainability realizing digi-circularity.

DIGITAL FACTORY

The vision behind the implementation of the Digital Factory aims to organize Hitachi Rail industrial sites with the introduction of key technologies able to work together transforming the manufacturing process from a traditional supply chain to a **smart network of activities**.[145]

Leveraging on the **Hitachi** technology platforms, Lumada and Pentaho, the collaboration between the human intelligence (People & Organization) and machine learning (Digital & data platform) generates valuable datasets that enable **robust quality controls**, increase product reliability (e.g. continuous real-time monitoring dashboard, predictive and condition-based maintenance, minimization of losses by predicting quality problems, etc.) and **energetic efficiency** (e.g. reduction of energy consumption, optimization of the pressure, minimization of water use, etc.).

In terms of quality-controls, the new technologies of the Digital Factory are introduced to create a process of gradual improvement made up of four different phases: installation, connection, analysis and integration. As a first step, production and quality machines are connected in order to extract data from all the major measurable elements of the factory and have an overall operational view. Secondly, data is blended to detect unseen problem equipment and line problems. Subsequently, predictive maintenance maximizes machine availability and predictive quality minimizes scrap and rework. Finally, through integration, all the processes are optimized generating full life-cycle production insights.

Regarding energy efficiency, Hitachi Rail SpA has undertaken a path towards energy efficiency which unfolds into three different steps. Firstly, it implies to reconstruct energy consumption profiles through energy sources census and the reconstruction of downstream consumption. Then, through the adoption of the H-Vision model, all the measurement data are channeled towards the identification of the focal points where power is used. Lastly, levering on the monitoring infrastructure (more than 80 sensors across Hitachi Rail's plants at Naples, Pistoia and Reggio Calabria) and the continuous analysis of consumption, it is possible to identify the energetic bad habits and solve the eventual cases of sources waste.

The creation of a **competencies-driven** environment, capable to enhance the human element through training and skills development, is the precondition to this effective digital transformation of Hitachi's business. The organization constantly supports a shift in competencies and professional profiles towards new ways of working, adopting flexible and agile methodologies. This digitalization process also allows, via a meaningful and planned automation, to move workers towards higher value-added tasks.

At the same time, the successful implementation of this network of activities significantly relies on the **co-creation model**, determining effective synergies among Hitachi's firms, external collaboration with suppliers and clients throughout the entire supply chain, as well as via Open Innovation for data collection and management. In particular, the integrated working approach encourages

145 Today more than 90 sensors have been installed among the sites located in Naples, Pistoia and Reggio Calabria.

cross-plant and cross-geography collaboration, with positive effects of cross-contamination and best practices sharing across the whole Hitachi.

Data, when applied to analytical models based on the real needs of production processes and on the environment of the specific reality, are able to lead to automation and awareness of cost centers, inefficiency or negative impact, allowing their reduction or mitigation and improving productivity. IoT, AI and big data utilization foster **organizational agility**, intended as the capability of the company to rapidly change or adapt in response to changes in the market, which is a source of competitive advantage in a context of new industry-changing technologies.

Firms represent privileged actors in the implementation of smart and greener cities, manufacturing sites have the responsibility to minimize negative environmental and social impacts in the territory. Indeed, the final goal is not only **operational efficiency**, pursued by innovation of organizational models and digitalization of processes, but also to compete and foster business growth through operational excellence achieved with the integration of scale, scope and skills also in the support functions. The result is a truly smart factory, where the use of technology and data allows concrete positive impacts to be obtained, not only in terms of economic and production performance, but also in terms of improving the quality of work, attention to workers, creation of value and innovative capacity for the entire supply chain and the reduction of environmental impacts.

TRAIN OF THE FUTURE

Together with the factory, the output of the manufacturing process also benefits from technology, data and automation. Firstly, the quality, the depth of information and the improvements resulting from manufacturing operation excellence generate positive spillovers on the final product: since the design and engineering phase, the train is envisioned to provide **superior standards** in terms of expected life value, safety, environmental performances and passenger experience. Digitalization and innovation follow a twofold approach, impacting on both the **hardware** component (e.g. utilizing innovative recyclable materials) and on the **software** side, incorporating intelligent sensors for real data measurement, video analytics, driving assistant radars and cameras, obstacle detectors, train health-checks mentoring systems.

Moreover, advanced analytics allow the calculation of the best train parameters, optimization of noise and pollutant emission, guaranteeing live data stream with stations and control rooms. The positive benefits resulting from the implementation of these solutions are already visible on "Caravaggio", the regional train utilized by Trenitalia [146] for passenger transportation. Composed of 5 cars for a total 136m length, with a total capacity of 656 passengers, the train architecture, light weight design and high efficiency propulsion allow unique performances, including transport capacity per unit length, consumption per passenger/km, different fittings of the interiors according to the customers' needs.

Technology platforms like this, whose value generates combination of hardware and software services, represent a new paradigm in terms of security, connectivity and predictive maintenance, towards a greater customer centric development, in which quality standards are guaranteed by the efficient use of real time data and customers' feedbacks.

Additionally, in a context where sustainability and efficiency become core priorities and demand for mobility is also growing, the production of sustainable products, allowing clean and efficient ways of transport and a safe, reliable and customer centric alternative to individual mobility are key. Hitachi realizes alternatives not only to regional mobility through his innovative train platforms, but also to urban mobility, being committed towards the improvement of **trams' energetic efficiency** and an overall **harmonization within the urban space**.

Hitachi's last tram model has a plurality of advantages as driving comfort, high level of safety and flexibility, low environmental impact. The implementation of an innovative solution powered by electricity and supported by batteries can feed the tramlines safely and efficiently. The distinctive flexibility of this solution facilitates the smooth and seamless replacement of catenaries, safeguarding the architectural value of this historical location.

146 Trenitalia is a subsidiary of Ferrovie dello Stato Italiane, owned by the Italian Government, and the primary train operator in the country.

IMPACTS

The modality preferred by the major part of the Italians - road transportation - highly contributes to pollutant emissions. Indeed, it accounts for almost 20% of primary emissions of PM10 and, for 96 cities out of 120, more than 50% of the nitrogen oxides (NOx). In 2017 the private car was used in 57% of the trips (equal to 20.7 million), while only 21% of them (7.6 million trips) were made using local urban and suburban public transport services by road and rail.[147]

However, the **number of railways passengers has increased**, reaching 5.59 million in 2017 and setting a new record compared to 2012 (+7.9% vs. 2014).[148] In fact, 2,874,000 people use the regional railway service every day and 2,716,000 people take daily the subways (which are present in only 7 Italian cities). These two transportation modalities are increasing with high-speed trains. Indeed, around 40,000 people take daily the Intercity and 170,000 high-speed trains (Trenitalia's Frecce and Italo) to travel on national routes.

Although these solutions are in constant growth, not all areas are well served. While Italian high-speed lines increased by 1,213 km since the beginning of the century, significant cancellations (for c.a. 1,12o km) and suspensions (for other 321 km) aroused and left several important areas of the country disconnected.

Despite this transition, in Italy trains and metros are **still underutilized** with respect to the EU average. Indeed, in 2017, the train share of total travels is 6.1% in Italy (vs. EU average of 7.7%). This is the lowest value among big-5 EU countries (Spain 6.6%, Germany 8.6, UK 8.8% and France 9.7%).[149] In terms of distance covered during a whole year, in 2014 – the most recent year to have a comparison at the European level – Italians moved by train for 804 km (vs. 1,005 in the UK, 1,126 in Germany and 1,359 in France).

The Italian railway infrastructures also present large heterogeneities. As an example, considering the density of the network respective to the regional population, several Southern regions are still scarcely equipped. The first region, Basilicata, has more than 900 km every million of inhabitants, whereas the best performer, Lazio, counts 231 km.[150]

Considering manufacturing advancements, in Italy, 80% of organisations are characterised by a technology profile with a **low level of digitisation**, while only 4.7% have a high level.[151] In spite of its dimension, this group gathers 7.5 million employees with high skills, contributes with a third of the total national added value, and invests more in technological equipment and rewards workers in terms of wages. The analysis conducted by Istat, the Italian National Institute of Statistics, confirm the existence of positive correlations between investments in automation, industrial innovation and the hiring of workers with a high professional and technical profile.[152]

The world of work is undergoing dramatic changes. With respect to other EU countries, however, **few Italian enterprises provide training**: in 2015 only 60.2% of Italian companies distributed training courses, vs. EU 72.6% and UK 85.7%. Italy also registers lower levels of participation to lifelong learning programs, with an 8.4% share of employees involved vs. 29.2% of Sweden, the best performer, and 11.1% EU average.[153]

Finally, in terms of adequate **digital skills** that companies require, 4 European companies out of 10 are already struggling to find the right talents to fill their vacancies, mainly due to a lack of profiles with adequate skills. Additionally, more than half of Italian companies with more than 10 employees adopt less than three types of digital technologies. Only the smallest part of these, just c.a. 10%, adopts 7 or more. Considering a European framework, only Bulgarian, Romanian and Latvians companies perform worst.[154]

The Digital Factory:

- Reduces environmental impacts through **better plant's performances** (reduction of raw materials, energy consumption, emissions, waste and pollution) achieved with the installation of sensors through which is possible to collect data and detect anomalies and inefficiencies;

147 ART – "Rapporto annuale 2019", 2019.
148 Legambiente – "Rapporto Pendolaria", 2018.
149 The European House – Ambrosetti elaboration on Eurostat data, 2019.
150 The European House – Ambrosetti, "Investire nel trasporto ferroviario regionale. Un'opportunità per le regioni italiane e per il paese", 2019.
151, 152 Istat – "Rapporto Annuale 2019 – La situazione del Paese", 2019.
153 Eurostat data, 2019.
154 The European House – Ambrosetti, "Geopolitica del Digitale: nuovi confini, crescita e sicurezza del paese", 2018.

- **Contributes to the local industrial fabric competitiveness** with cost reduction, improved productivity, time savings, volume increase, improved exports and turnover impact;
- Enables the delivery of reliable and valuable products with higher standards of quality (minimizing losses, detecting equipment and line problems, reducing reworked material and faulty products);
- **Diminishes costs linked to maintenance** and eliminates the time consumed by machine stops via predictive remote monitoring of quality, with an operational efficiency perspective;
- **Fosters internal and external positive contamination** through the acquisition of domain knowledge from historical and real-time data and improve the overall framework with a tailored approach;
- **Enhances human resources capital** through training and the development of specific digital competences and skills, favoring the hiring of high-skilled personal and introducing new operational and organizational models;
- **Fosters innovativeness and investments** and incentivizes the meaningful digitalization of the players along the value chain - including small and medium actors - increasing their competitiveness and their internationalization potential.

The technology of Hitachi regarding the IoTrain:

- Positively affects economics and operator performance, improves expected life-span of the vehicles, increase the efficiency of the fleet and reduced operational and maintenance costs thanks to better planning and real-time health check monitoring;
- Guarantees **better travel experience**, in terms of safety, punctuality and reliability indexes, increasing public transport services attractiveness and accessibility with higher passenger usage and better intermodal connections, especially between urban and extra-urban areas;
- **Reduces energy consumption**, polluting and noise emissions and waste production thanks to a higher share of recyclability of vehicles' components;
- **Limits the economic and social costs** connected to the CO_2 produced by alternative major transportation methodologies;
- **Enables the creation of an effective and efficient transportation system** at the national level, improving the connectivity of the peninsula, decreasing congestion at stations and in trains, adjusting train frequency according to real-time demand and having a continuous information and data stream among vehicles, stations and Control Rooms.

DIGITAL FACTORY

Considering the cumulated values of Hitachi Rail SpA plants located in Naples, Pistoia and Reggio Calabria, the introduction of a business transformation towards digitalization and structural efficiency permitted to generate positive economic, environmental and social impacts. The following data measure the variation of a selection of KPIs, cornerstones of a new energetic policy of Hitachi Rail, between 2018 fiscal year and 2017.

-50% welding defects, a core element in the railway sector

-50% maintenance costs and zeroing the time consumed by machine stops

-1.5% of total energy consumption

-13.0% of natural gas use

-16.0% in the ratio between the total energy consumption and the worked hours

Considering Hitachi Rail SpA environmental performances in 2018, significantly improved since 2016, it is possible to make a comparison with the Italian manufacturing sector average. If this sector would have performed as Hitachi Rail plants, its savings would have been:[155]

-38.5 million GJ of gas consumption

-12.6 million tons of waste production

-46.6 million tons of CO_2 emissions

Even more, the Digital Factory sensors permitted to individuate specific areas of waste where to intervene. These led to operational optimizations such as:

-52% reduction of the lighting costs along the painting process, thanks to the utilization of magnetic induction technologies and the optimization of the points of light

- Improved work quality conditions, thanks to the introduction of lamps with the right intensity and color gradation

- €30,000/year of electricity savings, with the optimization of the extraction systems for the welding fume via the installation of touch screen boards which permits to activate the air-extraction in specific time ranges

- €15,000/year, savings coming from the individuation of water leakages in the industrial water circuit

Hitachi Rail's digitalization also permitted to improve the share of high-qualified workers employed in activities with a high added-value and increase the skills formation:

~45% of the workers hired between 2016 and 2018 was represented by engineers and technicians

+c.a. 5,000, hours of formation proved to the worker to enhance their digital capabilities (e.g. IoT Masterclass course) in only six months of 2019

TRAIN OF THE FUTURE (CARAVAGGIO)

Caravaggio is a Regional Train designed for the transport of passengers utilising single and double-deck electric multiple units made of highly recyclable materials.

Recyclability rate: 95.8%, out of 204,620 kg of vehicle mass, 196,089 kg are recyclable

Recoverability rate: 97.1%, 2,536 additional kg can be utilised for energy recovery

Thanks to the most innovative applications of Hitachi, Caravaggio has one of the lowest rates in the market in terms of greenhouse gas emissions.

5.109 grams of CO_2 equivalent / (km * person)

The regional trains represent a major transportation solution for Italian population, especially considering that every day almost 2.9 million people use it and this modality is continuously growing (+1.2% passengers in 2017 vs. 2016). Regional railways enable, therefore, nodes connections mainly from extra-urban to urban areas for commuting workers.

In a hypothetical scenario where all the regional trains would have the same emission of Hitachi's Caravaggio in terms of greenhouse gasses, expressed as CO_2 -equivalents per passenger per km, the environmental and socio-economic benefits would be substantial.[156]

The following analysis takes into consideration the avoided tons of CO_2 in a year not-generate by total daily commuters on the regional lines.[157]

~223,842 tons of CO_2 saved thanks to the higher train efficiency, which correspond to **€5.9 million** of direct costs* and **€25.9 million** of indirect costs**

Therefore, the sum of direct and indirect costs linked to CO_2 emissions is **€31.8 million** of total costs avoided

* Direct costs of CO_2 resulting from the price of European Carbon Allowances trade on the EU ETS market.

** Social costs resulting from the negative externalities of CO_2 as decrease of the level of agricultural production, productivity of workers, increase in health costs, increase in expenditure for protection and restoration of the environment, etc. The value reported refers to the average between the conversion factors elaborated by EPA and Stanford University.

155 The European House – Ambrosetti elaboration on Hitachi, OECD and Istat data, 2019.
156 The European House – Ambrosetti elaboration on Hitachi and EEA data, 2019.
157 The European House – Ambrosetti elaboration on Legambiente and Censis data, 2019.

TRAIN OF THE FUTURE (TRAM)

Hitachi has developed a new tram model, which improves environmental performances and guarantees an elevated passengers' capacity. Additionally, it also presents a new innovative catenary-free system designed to have the lowest impact on cities. The distinctive feature of this product resolves the criticalities deriving from the presence of a catenary system, especially in terms of infrastructural costs, thanks to the use of batteries. The battery innovation guarantees the maximum safety of the vehicle and allows Hitachi's tram to easily cross the historical centres of Italian cities, preserving their historical and artistic value.

~ €25.2 million, avoided costs for the displacement of sub-services thanks to the provision of a non-catenary system (considering the initial costs of infrastructure development for a new medium length tramway in Italy)

The scenario described beneath quantifies the differentials in terms of CO_2 emissions per passenger-km and occupied space, considering that Hitachi's tram passenger capacity corresponds to c.a. 145 cars (in terms of an average car utilization). These differentials have been applied considering the tram utilization trends of a representative mid-size Italian city.[158]

~1.89 tons of CO_2 yearly saved thanks to the tram utilization rather than the car

~154 km² of CO_2 yearly saved thanks to the tram utilization rather than the car [159]

- than the whole surface occupied by the City of Bologna, the 7th Italian city per population [160]

A high-quality public transport provision, as the one offered by Hitachi, encourages the utilization of not only greener but also safer means. Only in 2017, the differential emerging from road mortal accidents occurrence between trams and cars[161] (0,4) corresponds to a substantial monetary value for the country.[162]

~ €462 million, difference in social costs of fatal road accidents between cars and trams [163]

The average social cost per fatal road accident corresponds to the sum of average cost of living, loss of productivity, non-assets damage and healthcare costs [164]

Key Takeaways:

Public and private players are today called upon to find innovative and sustainable solutions to meet the growing demand for mobility of Italians. On one side, Hitachi is able to produce technologies enabling green mobility solutions, such as highly innovative and high-performance trams and trains, capable of incentivize rail transport through specific features of the product. On the other side, Hitachi achieves cutting-edge and sustainable manufacturing processes. This double action benefits from investments in digitization, innovation and training and a co-creation approach involving the several various stakeholders involved. By doing so, Hitachi allows to match automation with positive social effects, sustainable growth with economic performance, and to close the circle between production (corporate impact) and product (business impact). This is paradigmatic of Hitachi approach to digi-circularity, which contributes to realize Society 5.0 in Italy answering to several needs of Italian society (mobility, economic growth, competitiveness, training, digitization of SME, …).

158 The European House – Ambrosetti elaboration on Hitachi and EEA data, 2019.
159 The calculation considers an average passengers' car occupancy of 1.5, as reported by EEA.
160 Istat data, 2019.
161 Inail – Report "Gli incidenti con mezzo di trasporto", 2019.
162 Considering the occurrence of fatal road accidents in the 14 Italian metropolitan cities.
163 The European House – Ambrosetti elaboration on Inail and Istat data, 2019.
164 Italian Ministry of Infrastructure and Transport.

05 The creation of Society 5.0 in Italy: priority areas for the country system

To realize a human-centered and sustainable society in Italy, according to a Society 5.0-based model, a **true cooperation of multiple social actors is required**. Cooperation is key to deliver effective innovative solutions, that leverage on forefront technologies and that are capable to address major social needs, solving those issues that today affect the sustainable development of Italy from an economic, social and environmental standpoints. >

To enable such cooperation and to realize Society 5.0, Italy and all its stakeholders must recognize the importance of a strong and joint action on **few major systemic priorities** at several intertwined levels. These priorities are pivotal to solve major problems that today hinder co-creation and hamper the development of innovative solutions or limit their effectiveness.

First, a strong action on **digital competences and up-skilling must be made**. The 2019 OECD Skill Outlook scoreboard shows that Italy's population lacks the necessary foundational skills to succeed in a digital world (both as individuals and workers). Only 36% of individuals in Italy can make a complex and diversified use of the Internet. It is the lowest level among OECD countries with available comparable data. Moreover, Italian workers are using ICTs on the job less intensively than in many other OECD countries.

Nor **education** is working to address this delay. Only 30% of adults have received non-formal and informal training in the past 12 months, against an OECD average of 42%. In Italy, moreover, only 21% of individuals aged 16-65 have a good level of literacy and numeracy skills (i.e. score at least Level 3 in PIAAC literacy and numeracy tests). This is the 3rd worst performance among countries for which information is available. While in several countries teachers use ICTs with the same intensity than other tertiary-educated workers, in Italy teachers use technology well below other high-skilled workers. Additionally, 3 out of 4 teachers report needing further training in ICT for teaching.

As a consequence, an increasingly worrying **skill gap** is growing in the country, linking technological progress with fear of unemployment and uncertainty for the future. The gap between supply and demand of digital skills is demonstrated by numbers that saw in 2018 a need for 12,800 to 20,500 figures, while the University-system graduated just over 8,500 (7,700 in 2017). The specialists in information technology and computer engineering are just less than 5,000. The skill gap hence reaches 58% and risks to expand drastically over the next three years, when the possible profiles required should exceed 70 thousand.[165]

165 Source: "Digital Competence Observatory 2018", conducted by Aica, Anitec-Assinform, Assintel and Assinter Italia in collaboration with Miur and Agid.

To solve this issue companies, actors of innovation, universities and educational system, together with the government, should **act jointly**. To fill this gap, they must improve life-long learning education and promote it, incentivize upskilling and reskilling of the workforce, deploy meaningful incentives and impactful investments on digital competences' creation. Moreover, digital skills should be integrated within existing managerial or technical profiles, as innovation and digitization produce effects only if they are embedded within existing business models, transforming them and producing changes in operating and organizational models.

As of today, companies can only choose between being a digital player or not be. In this sense, only 8% of Italian companies utilized at least one fully-4.0 technology in 2018, while 59.4% of companies had yet to make any type of investment or had not shown any effort to innovate and 13.6% had a low propensity for innovation (undertaking a simple renewal of equipment without any change in productive or organizational processes). To solve this issue, which is partly due to lack of resources, and partly tied to culture, once again an integrated effort can be effective. A value-chain based approach would have enormous impact fostering meaningful digital transformation of corporate processes and organization of the workplace.

As of today, only 15% of Italian companies have introduced some sort of process or organizational innovation, and even these efforts remain partial.[166] In addition, it involves only large manufacturing companies and/or companies in medium- to high-tech sectors with greater resources for investments. Although these companies are statistically and numerically limited within the Italian economy, they can have a tremendous **catalyst effect** in stimulating the adoption of paradigms that are fully 4.0 downstream, acting on suppliers and on requirements for their selection. Through procurement and supplier relations, major industrial players and supply chain leaders in given sectors can, in fact, stimulate positive behavior and provide soft and hard incentives to SMEs to undertake the investments that are truly needed (on the basis of suitability and proportionality), stimulating a 360° digital transformation of the country's manufacturing base.

This approach could promote a **gradual and balanced evolution, especially from a cultural standpoint**, but also requires propensity to cooperate and to embrace Open Innovation. As of today, Italian companies do not seem very prone to take part in innovative networks and to create research, development and co-creation partnerships on a national and international level.[167]

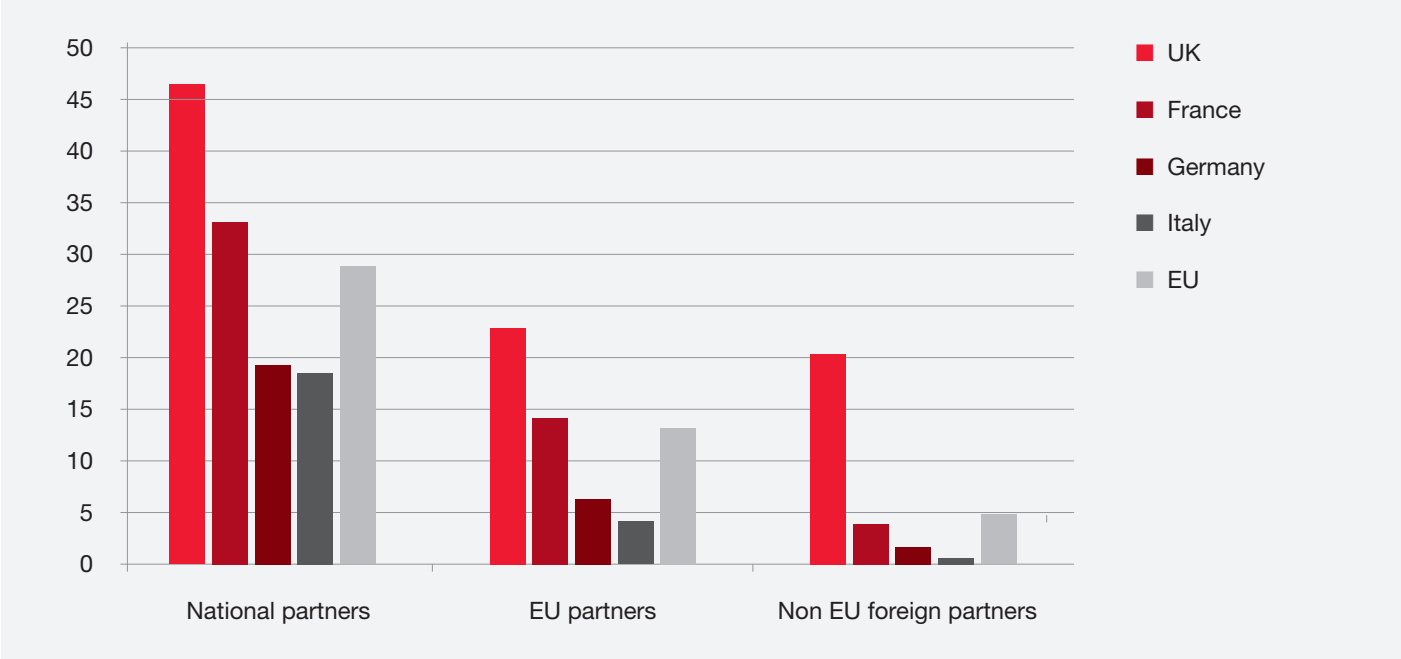

Figure 5.1: Innovative companies with cooperation agreements by type of partner in principal European countries, 2014 (%). Source: The European House – Ambrosetti elaboration of ISTAT data, 2019.

166 MiSE – Report "La diffusione delle imprese 4.0 e le politiche", 2018.
167 Istat - Annual Report, 2018.

A field where cooperation and investments could begin to take roots is the one of **data economy**. To deliver integrated and valuable services and to leverage on data value, especially within public utility services' sector, architectures and platforms should be co-designed and co-developed with the cooperation of multiple actors including Public Administration, service providers, technology providers and integrators, funding agencies and, of course, citizens and communities. To achieve interoperability, shared standards, approaches and languages should be defined and agreed since the beginning.

A pre-requirement is the capability, by **Public Administration**, to set a strategy to recognize the value behind Society 5.0 concept, to manage tenders, to lead the co-design processes, to carry out data collection, management and analysis and then to share meaningful information. It also has to incentivize virtuous behaviors.

To do so, **technical staff** must be competent, fit for purpose and capable to make right decisions. Lack of competences, on the contrary, risks to leave the initiative to single players, such as technology integrators. The latter is a less effective alternative compared to a system capable to leverage on a Smart-Public Administration that provides horizontal platforms' standards, strategical guidance and fit-for-purpose policies. In this sense, a priority is training of civil servants and public managers to update the basket of competences today available.

To boost **PPPs (public-private partnerships)**, which are key enabling element for Society 5.0 establishment, governance 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.

Given so, Public Administration results crucial. It must lead dialogue, define the strategy, provide the guarantees to stimulate co-design, the guidance, the standards and the supportive regulation (e.g. in data management), together with **clear targets and transparent priorities** since the very beginning. This allows scalability and avoids the risk of future technological lock-in of specific companies or players.

Public defines modalities to collect and share data and provides central intermediation. This is crucial since integrated services and models based on data

168 This topic is investigated deeply in the "Connected Cities Initiative" Position Papers, realized by The European House – Ambrosetti and Hitachi in 2018 and titled "Study on Smart Infrastructures: how integrated mobility, energy and water services can improve citizens' quality of life" and "Smart Safety: how new digital technologies can make our cities safer".

are not working on centralized processes, but on **horizontal, decentralized and integrated models**. For this reason, all stakeholders should play their part. Dialogue, co-design and co-development are a priority as well.

Financial institutions, funding agencies and public budget governance must take an active part too. The level of capital and financing in innovation, digitalization and R&D remains low in Italy, from both public and private sector sources. Specifically, the government's budget for R&D activities is still low, below 0.6% of national GDP. The financial backing from companies for new innovative startups and businesses is also insufficient and lower than other EU competitors, especially in **early stage financing and corporate venture capital** (CVC), an area in which Italy remains at the bottom among EU Member States (e.g. considering financing as a percentage of GDP and in terms of "coverage" of these financial sources as shown by the venture capital-backed companies' rate).

Conversely, **financial players** can be extremely effective in incentivizing dialogue and co-design, playing a far more effective role than legislation. Through financing schemes, they should incentivize public-private partnerships, open innovation, networking with research institutions and start-ups, guaranteeing cooperation, integration, transparency, and interoperability.

In conclusion, what is most urgently needed to allow the intake of Society 5.0 within the Italian context is the **mindset for cooperation and the soft infrastructures** (culture, skills, practices, organizational and operational models) **underlying digital transformation**. Fostering them, innovative solutions can thrive, budding from cooperation between public and private, between innovation players and traditional ones, involving academia and citizens. Through co-creation and cooperation, technology can avoid being a source of social fractures or fear (e.g. in the case of automation), can go beyond the sheer delivery of basic tech-gadgets and improved business performances.
On the contrary, embracing the Society 5.0 paradigm and enabling it, technology and innovation can begin to deliver impactful solutions, capable to put citizens at the core, to solve social issues, to responsively address individual and social needs, and to support a sustainable development from economic, social and environmental standpoints.

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