Harvard Business Review
ITALIA

HITACHI, A TRUE CLIMATE CHANGE INNOVATOR BOOSTING THE RACE TO ZERO

SUMMARY

1. HITACHI GROUP OVERVIEW: MANY COMPANIES, ONE SOUL

1.1. Hitachi at a glance: inspiring the next since 1910

Hitachi was founded in 1910, when founder Namihei Odaira was just 36 years old. He established an engineering department at Hitachi Mine, part of the Kuhara Mining Company, that was used as an internal repair shop of equipment coming from foreign manufacturers.

Original repair shop in Ibaraki, 1910

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When Odaira was kept busy with repair work and relocations, he thought: "Break-proof products with high performance would need less repair and improve the operating rate of the mine. Can't we make good products on our own instead of continuing to rely on products made overseas?".
Not without difficulties, Odaira persisted to realize the potential of the production business and its necessity.

"Our aim is to build equipment for the mine, solidly and fast", Odaira would say, and they produced anything and everything from transformers, oil load-break switches and electric motors, to electric generators, circuit breakers and electric switchboards.

Namihei Odaira, Hitachi's founder, 1910

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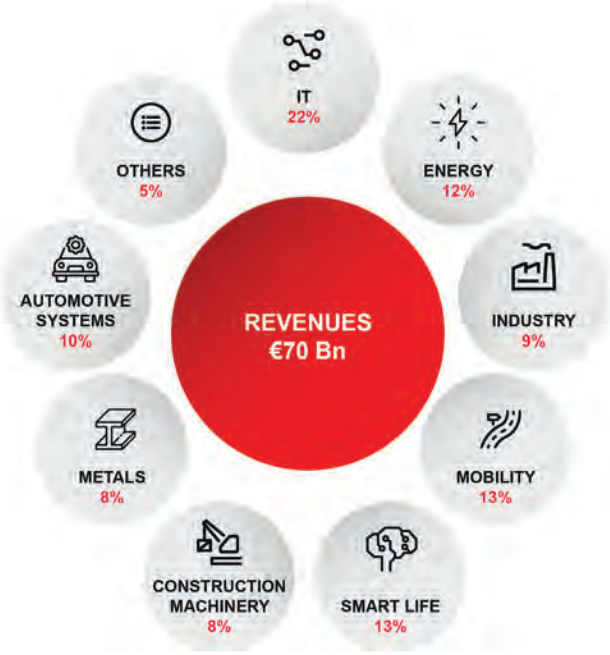
In February 1920, ten years after its birth, Hitachi parted from Kuhara Mining and became Hitachi, Ltd., headquartered in Tokyo.
The company then expanded into a wide range of product portfolios and businesses, becoming one of the so-called Big-8 "General Electronics Manufacturers" of Japan's past. In recent years, Hitachi has transformed further to focus on social infrastructure, with core technologies in Energy, Railway, Elevators, Industrial Products/Systems, Medical Equipment, Automotive Components, and core capabilities in IT Services and Consulting.

Today, Hitachi has more than 800 companies around the world, and in 2020 generated approximately €70 billion annual revenues and €4 billion net income attributable to its stockholders. The company competes on a global scale, being one of a handful of companies in the world that has the capabilities to control and operate social infrastructure and deliver sophisticated information technology under one roof. Hitachi calls this its Social Innovation Business – with an overall aim of powering good in the world and creating a better quality of life for everyone.

Hitachi's revenues breakdown by industry, FY2020



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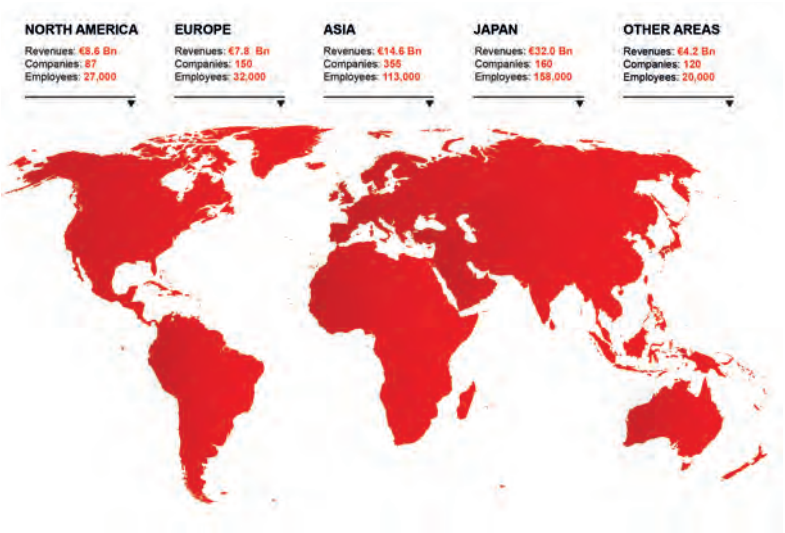
Hitachi's global footprint, FY2020



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1.2. Hitachi's Mission, Values and Vision

The Mission to "Contribute to society through the development of superior, original technology and products" originally set by the founder Odaira, has been carefully passed on to generations of employees and stakeholders.

Hitachi's century-long history has shaped this Mission, and we are proud to support society and help realize a more comfortable and safer world through our technology and products.

The Values – Harmony, Sincerity, and Pioneering Spirit – reflect the Hitachi Founding Spirit, and have been embraced with care by our predecessors for over a century as they worked hard to fulfill Hitachi's Mission.

This spirit resonates through the way we think and operate, as we collectively strive to deliver solutions that create new value globally.

The Vision has been created based on the Mission and Values. It is an expression of what the Hitachi Group aims to become in the future as it advances to its next stage of growth: "Hitachi delivers innovations that answer society's challenges. With our talented team and proven experience in global markets, we can inspire the world".

To achieve greater advancements, address today's global challenges in resources, energy, and the environment, and build a sustainable society, we have created the Vision as a fresh expression of what the Hitachi Group aspires to be in the future.

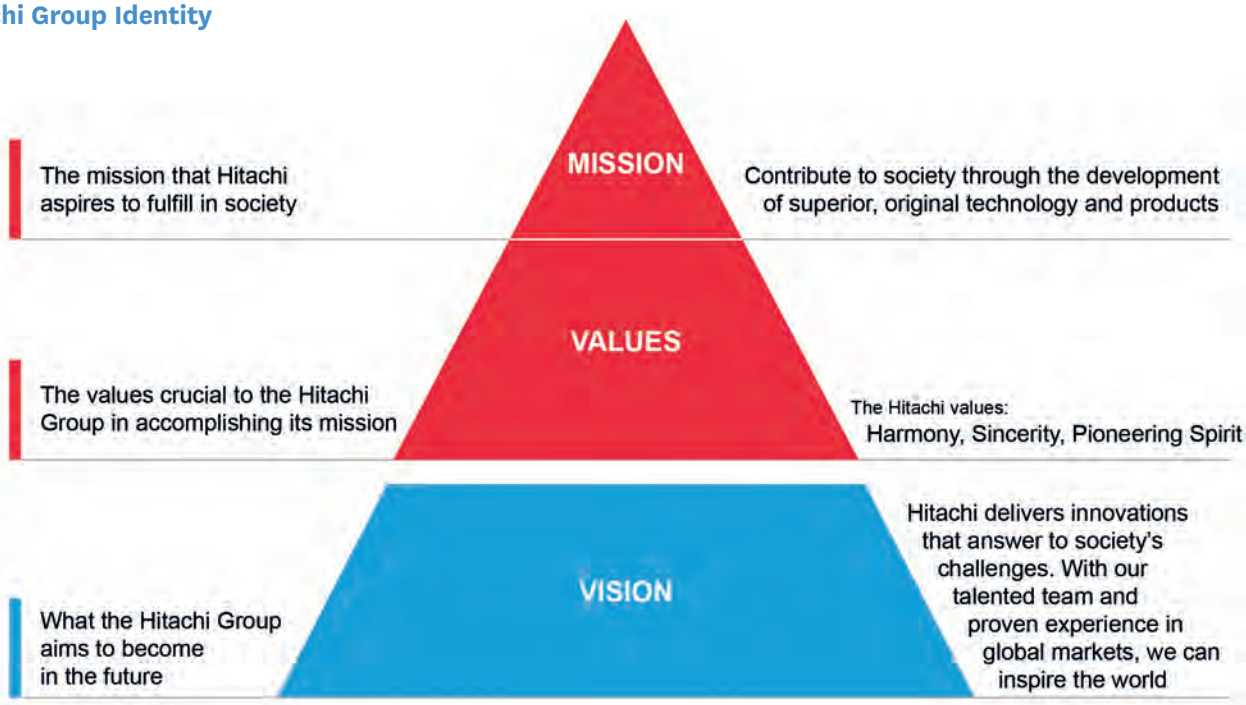
Together, our Mission, Values and Vision are made to be shared in a simple concept: Hitachi Group Identity.

With this Identity that today unites a workforce of more than 350,000 people worldwide, we work for our shared dream, and for our goal of building a better world.

1.3. Hitachi's global imperative: social innovation and co-creation

The global imperative to innovate and address the local challenges of the fast-moving modern world is what creates the concept of social innovation for Hitachi.

Hitachi Group Identity



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Our vision of the future is changing because the world around us is constantly evolving. The drivers for this are both external influences such as resource scarcity, rapid population growth, climate change and the increasingly crowded streets, but also the drastic change of values within our society. Innovation can and should deliver life-changing solutions for society and individuals. Hitachi can bring about social innovation through its key strength – bringing together its technological and human capabilities, with technology convergence and IT as the glue that binds them all.

This idea has strong links to the concept of creating shared value (CSV), which encompasses many stakeholders, such as companies, governments, NGOs, public sector organizations and therefore also plays a major role in society.

Other interpretations focus on the business value of innovation to deliver advancements for society by opening untapped markets with profitable business models.

Hitachi operates at the intersection of CSV and business value creation. As a visionary global player, we have a thought-leading position in the sphere of social innovation.

It has been more than 10 years since Hitachi began to pursue social innovation, and we have learned much during this period as the concept has evolved with changing times and social circumstances.

One example of Hitachi's social innovation solutions is our Class 395 rolling stock for the UK, which began operations in December 2009. In one incident, approximately 500 people were trapped inside a train that had come to a halt in the Channel Tunnel between the UK and France. To make matters worse, the incident occurred as heavy snowfall in the surrounding areas prevented most trains from operating. Fortunately, the Class 395 train, which can run smoothly even in snowy conditions, came to the rescue and carried the 500 passengers to safety. This incident cemented Hitachi's reputation for quality products.

The Class 395 is a commuter train serving London and its surrounding areas. It has succeeded in cutting the travel time between London and Ashford in half. One delighted commuter commented, "Not having to leave so early in the morning frees up precious time that I can now spend having breakfast with my children. I am truly grateful for Hitachi's train". Hitachi takes great pride in know-

ing that it is allowing people to have more time for the "good things in life".

Particle Beam Therapy (PBT) is another important way Hitachi's product can help people. Hitachi PBT systems have been used to treat more than 80,000 cancer patients around the world. A patient who was treated at the MD Anderson Cancer Center in the USA a few years ago tearfully stated that "Hitachi's PBT has helped treat my cancer". Another patient treated at a different Hitachi PBT site recovered to such an extent that he was able to successfully complete a marathon three years after undergoing PBT. These accomplishments arose from the tenacity and efforts of doctors, but we are proud to contribute to society and cancer therapy using our technology.

To bring Social Innovation Business to life, Hitachi focuses on collaborative creation – what we like to call "Co-Creation". It is a way to generate innovation to overcome societal challenges directly involving governments, communities and corporations.

Hitachi's Social Innovation Business key stakeholders

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Co-creation reaches deep into industries and across supply chains, as well as between suppliers and regions, creating shared value at every step along the value chain.

This means realizing a sustainable society by understanding global, social and environmental expectations through communication with stakeholders and integrating those expectations into management and business value creation.

Hitachi began working with companies on co-creation at the same time as the Center for Social Innovation (CSI) was launched in 2015, with the number of projects reaching 1,000 in FY2018, up from 175 in FY2016.

A difficultly with the past practice of one-to-one co-creation, however, is that it was not easy to expand to other partners or scale globally. An important factor in successful up-scaling is the building of a global innovation ecosystem that creates a large amount of value through the application of a wider range of knowledge and insights from both inside and outside the company. This includes researchers and designers from Hitachi, startup companies, community residents, and universities.

Therefore, in April 2019 Hitachi established a new facility nestled in the woods of Musashino in Kokubunji City, Tokyo called Kyōsō-no-Mori (Collaborative Forest). In this ecosystem the goal was to come up with innovative digital solutions and services through open innovation, evolving from one-to-one collaborative creation.

More than merely a place for generating ideas through discussion, Kyōsō-no-Mori provides opportunities for stakeholders – including other companies, universities, and government agencies – to work with researchers and designers to identify challenges and create practical business solutions.

The facility offers the possibility to accelerate open and collaborative innovation through a rapid cycle of prototyping and testing using Hitachi's Lumada IoT Platform and other leading-edge technologies. Research topics cover a wide range, including autonomous cooperative robots and energy management. Hitachi aims to take ideas that emerge from discussions at Kyōsō-no-Mori with people from all around the world and to utilize digital technology and collaborative creation to put them into practice.

As said, the most important aspect of co-creation is the ability to work with customers to identify challenges and achieve a common understanding. It is for this reason that Hitachi uses NEXPERIENCE, a consolidated framework of methodologies for developing new services and business models through joint workshops with customers.

A collaborative creation with Amada Holdings Co., Ltd., a major international manufacturer of metal processing machines, leveraged Hitachi's manufacturing expertise.

Adapting to changes to production plans, such as the types and quantities of products produced,

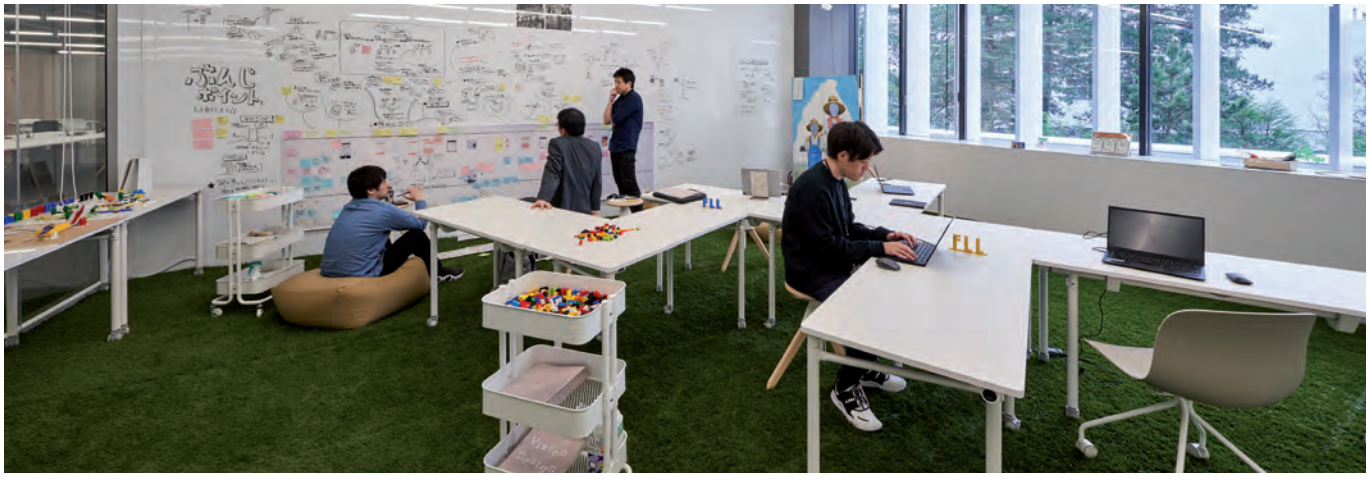
was a major manufacturing issue at Amada. In the past, common practice was to rely on the accumulated expertise of workers to ensure that products were delivered on time. In fact, we face similar concerns in our own operations at Hitachi. In response, we have installed plant sensors to monitor work progress and have developed factory simulators that we can use on Lumada to modify production plans. We invited expert workers from Amada to view our practices; using their know-how, they implemented our practices into their own systems to coordinate production. This has shortened the task of production planning by around 80%.

Amada has also introduced a hands-free system for managing work processes that incorporates Hitachi technology for image and voice recognition into three dimensional (3D) images to provide work instructions. Workplace improvements such as this ensure that even workers who lack experience are able to maintain high levels of skill.

We are proud to say that the process of innovating with partners by bringing stakeholders directly into the process has been a unique way for Hitachi to develop innovative new products and services for business stakeholders, customers and society at large.

Kyōsō-no-Mori at the Central Research Laboratory

The name embodies the idea of growing along with the forest, spreading innovation while cultivating its seeds into a vast forest together with customers and other partners. Constructed in the midst of trees, the Kyōsō-no-Mori features an architectural design that takes account of the environment, including use of a high side terrace that encourages natural lighting and natural air flow and ventilation.



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Interview to Ram Ramachander, Chief Commercial Officer, Social Innovation Business EMEA & Chief Digital Officer, Hitachi Europe, September 2021

Social Innovation has been part of our mission statement since 1910. The Idea is to innovate with superior technology to improve society. This is not just a mission statement, it's also a philosophy, an approach. I think Social Innovation is very relevant to modern day challenges – ranging from Climate Change to Covid. The best way to frame Social Innovation in today's environment, is to look at the 17 UN Sustainable Development Goals, which are really an agenda for the future of the Planet. Social Innovation is innovation that advances and accelerates this agenda through technological improvements. My business unit acts almost like a startup, like an agile unit, and looks at the major challenges that are happening in the market (such as Climate Change) and starts developing transformative ventures. Let's take for example Electric Vehicles (EVs): if you take energy capability, mobility capability and digital capability as different units, we bring all of them together, then we partner with external innovators and start-ups and other partners to create a new transformative venture that is going to accelerate the uptake of EVs, enabling at the same time energy companies to meet the electricity need.

When it comes to decarbonizing different countries and societies, there is not a one-size fits all solution. You always mention the necessity to create an ecosystem that interconnects different businesses and technologies, to fully leverage the potential of each solution in the fight against climate change. Can you elaborate on this idea?

It is important that when we get to conferences such as COP26 we reach an agreement on common goals, common targets and common agendas across the planet to create momentum. At a regional and country level, we need strong policies to be able to drive plans which are specific to that area. This is the reason why I always talk about having a slightly different approach in Europe versus APAC, or versus America. As far as ecosystems are concerned, as we transition out of our traditional systems into greener infrastructures, new ecosystems get created. Again, I will use EVs as an example here. Today we go to the gas station to fill up our car. However, once we adopt EVs on a vast scale, we will be plugged into the grid, so we'll need a charger. We'll pay attention to the range of our cars and how much energy we are utilizing while driving. The energy companies, in turn, will worry about how many vehicles will be plugged into the grid at any point in time. We are now creating a brand-new value chain, a value chain that is more distributed and has more complex interconnections. It is important to recognize this complexity and start to deal with it. The underlying thread that brings together all the elements of this value chain is data and digital. It is very important that we manage this infrastructure using digital technology, optimizing how we connect this system together.

You have worked in Silicon Valley, witnessing many start-ups grow and flourish, and other go →

→ **bust. When you think about the vast array of technologies available to facilitate the ecological transition, which ones do you think have the most potential to be scaled up and widely adopted?**

The thing I watch quite a lot is where investments are going. Where is the money going in the Valley? Right now, nearly 60% of all the funds' investments in Silicon Valley are directed to Mobility and Transportation, followed by the Energy Supply sector. Energy Supply, Mobility, Transportation account together for 70% of the investments. Focusing very hard on enabling these transitions is, as a company, quite lucrative. The kind of areas we can think about are road transportation optimization, battery management optimization, charger infrastructures and a transition to possible hydrogen technologies – either in the supply or mobility world. Digital proliferates across all areas, but this time it is quite embedded in the solution itself. At Hitachi we bring these different technologies together into a single solution for our customers.

68% of World population is projected to live in urban areas by 2050, according to the United Nations. How is Hitachi contributing to develop more sustainable and smart cities, raising the living standards of their inhabitants?

Hitachi has a lot of capability in infrastructures, energy, transportation, etc. One of the things we are starting to think about is: "how do we connect all these elements in a smart city environment?". A few years ago, the conversation around Smart Cities was quite nebulous – the conversation was in fact so big that no one could get their heads around how to transform a city into a more sustainable environment. It was a problem too big to solve. We then started to solve component-related issues, such as optimizing renewable energy, optimizing distributed energy, etc. Now, we are thinking about connecting Mobility across multimodal areas to create a more efficient mobility environment. For instance, our Rail Business is pushing forward with the Mobility as a Service Capability, connecting rails to the public transportation network and to the last mile travel, to create a much more seamless and efficient travel experience. When you join that with the EV work we are doing, you get a coupling of decarbonized transportation with intelligent Maas, making the whole process of travel a much more efficient way of moving the city forward. It's complicated, but we are now putting the puzzles pieces together to create whole sustainable cities.

What does Climate Innovation mean to you?

Firstly, we need to bridge the gap between the enormous amount of private funding that is available and the amount of funding that is available from the government. To encourage the ecological transition, Governments will continue to grant funding, but we need to take this public funding to create momentum in private sector funding or among the ESG funds that will invest in new green infrastructures. To bring these two worlds together, we need to bridge a gap, a gap of understanding between how the financial world sees risk and the management of risks in future infrastructures, and what the policies are that are driving that transition. If you do that, we can accelerate the development of solutions to climate change. Secondly, we need to bring innovation into business models. Again, look at EVs: electrifying fleets counting maybe thousands of vehicles is a very expensive process for a company, even for a government. It is therefore paramount that very big companies like Hitachi, or other large organizations, start to introduce business models into the world, models that can transform CAPEX-intensive business models into OPEX-oriented business models such as "pence-per-mile" models, or business models based on monthly regular costs. I believe that the thinking now needs to move into financing and business modelling rather than only on technological innovation.

1.4. Hitachi's evolution: snapshot of company's transformation in the last decade

In 2010, Hitachi marked its 100th anniversary since founder Namihei Odaira built an office and a factory on a 13,223 sqm plot of wasteland at a Hitachi mine in Ibaraki Prefecture, based on his philosophy that Japanese industry would never develop unless Japan began manufacturing its own products.

In this century-old journey, Hitachi managed, with great effort, to embrace different phases of change, evolving into the international company it is today – always pushing into fast-growing fields capable of enhancing people's quality of life.

From a business perspective, Hitachi had the foresight to invest in Sustainability nearly a decade ahead of other geographies and industries.

In 2014, Toshiaki Higashihara was appointed as President. Higashihara completely reimagined Hitachi as an IT and infrastructure leader and invested his energies into the further utilization of digital technologies in the Social Innovation Business, which had continued to grow, and sought to bolster and speed up business operations.

Two years later, Hitachi built the Lumada Platform, a set of data analytics solutions and technologies that creates new value through digital innovation and customers' various operational data.

We aim to use Lumada to implement future cyber-physical systems (CPSs). CPSs are based on the concept of connecting cyber space with physical space – they use computers (cyber space) to collect data from sources such as sensors located in the field (physical space). These can then be analysed using technologies such as big data analytics and artificial intelligence (AI), and the results used as feedback to the physical systems. Achieving this requires expertise in both the physical and cyber worlds. Hitachi possesses both operational technology (OT) expertise, acquired from more than a century of experience with the supply, operation, and maintenance of a wide variety of products, as well as IT expertise that it has built up since the 1960s.

Thus, by consolidating common technologies which are essential to sophisticated solutions on a single platform, Hitachi is building a business portfolio of more than 1,000 customer use-cases and 85 solution cores to implement IoT systems for a broad range of industries, enabling Hitachi to compete globally.

Hitachi's acquisition of ABB's Power Grids business, July 2020

Toshiaki Higashihara, Executive Chairman & CEO and Director of Hitachi, said "Through this operation, we have been able to acquire excellent assets that will help make Hitachi a truly global company. The first asset is the basis for promoting our Social Innovation Business worldwide. By combining the new company's world-class power grid business with Hitachi's Lumada solutions to create a new energy platform, and furthermore, by leveraging the new company's global business model, we will be able to provide the best possible service in various industries and expand our Social Innovation Business globally. The second asset is the basis for enhancing Hitachi's global business management platform. The new company will feature a diverse group of talent and be a progressive global operation. Moreover, we must address the most challenging SDG indicator of building a zero-carbon society with various measure including the use of renewable energies. Hitachi and Hitachi ABB Power Grids will work together to take on this challenge and contribute to the realization of a sustainable society".

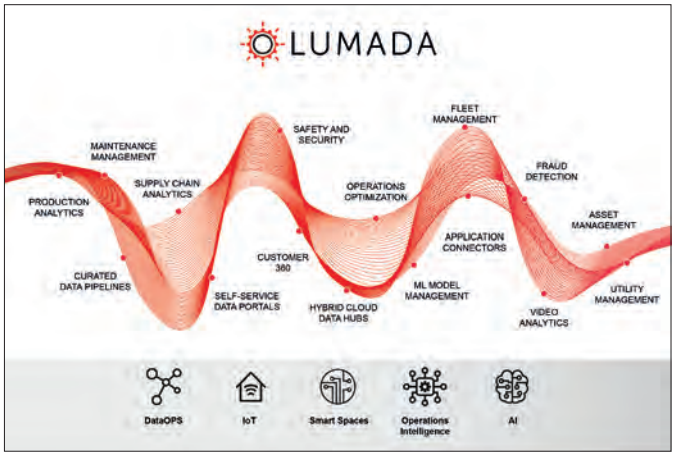
In the last couple years, meaningful M&A activity has been crucial for Hitachi to boost its overseas expansion and execute the Lumada growth strategy.

In December 2018, Hitachi finalized the acquisition of 80.1% of ABB's electricity grid assets for $6.85 billion, effective from 2020 – creating Hitachi ABB Power Grids (now from October to be renamed "Hitachi Energy"[1]). The strategic rationale of the acqui-

1 On 1 July 2021, Hitachi announced that its business entity Hitachi ABB Power Grids will be evolving to become Hitachi Energy from October 2021. At the time of printing / publishing the business was still called Hitachi ABB Power Grids. An update to reflect the change is planned to the online version in due course

sition relies on the fact that in the future, electricity supply into the grid would come from various decentralized power sources, including a large number of "prosumers" who both consume and supply electricity. This would make the traditional power grid unstable, and grid digitalisation would be crucial to implement Virtual Power Plant (VPP), grid aggregation and demand response functions.

Hitachi's Lumada Platform: Edge-to-Analytics



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By combining the ABB's competitive capabilities in grid technology, its strong global presence with business operations in 90 countries with Hitachi's Lumada data analytics solutions, Hitachi is now able to provide competitive solutions in energy management, automated distribution, utility network analysis and operation, P2P electric power exchange at a global scale.

In March 2021, Hitachi embarked on the overseas acquisition of GlobalLogic, a Silicon Valley software services company, for $9.5 billion. Hitachi will leverage GlobalLogic's strong digital engineering capabilities as well as their established design skills and vertical industry expertise in order to develop software for new products and digital experiences. This acquisition will therefore help accelerate the mission to transform Hitachi into a global, digital transformation innovator in social infrastructure worldwide, by strengthening Lumada's digital portfolio and propelling its global expansion plans forward. At the same time, Hitachi has identified five sectors – Mobility, Smart Life, Industry, Energy, IT – as growth areas in which it can leverage its advantages of digital technologies, control and operational technologies for social infrastructure, as well as its diverse range of products to increase social, environmental, and economic value for customers and society. In addition to a major business transformation, Hitachi has been able to carry out another profound change related to the company's human capital, touching on all the major pillars of Diversity, Inclusion and Equity. This is essential to successfully lead the business in its international sustainable expansion.

In April 2010, Hiroaki Nakanishi was appointed President. Nakanishi believed that the globaliza-

Hitachi to Acquire GlobalLogic, June 2021

Keiji Kojima, Hitachi newly appointed President, said "GlobalLogic acquisition comes after years of Hitachi's effort to transform the sprawling conglomerate into an IT and infrastructure specialist by merging and selling listed subsidiaries. With the asset restructuring program nearly complete, the next 10 years will be a decade of growth as the Group aims to expand its software business Lumada globally. Specifically looking at Lumada, I think of two phases. In Phase 1, our powerful IT team will use Lumada to utilize customers' data to innovate and help grow their operations. As far as I can see, Phase 1 is transitioning quite well in Japan.

In Phase 2, there are two things that we need to do. The operational innovation that we carried out in Phase 1 needs to be carried out overseas, and significant innovation needs to be brought about

tion of management and business was essential to further drive the Social Innovation Business.

In 2011, to accelerate the global expansion of Hitachi's business operations, he formulated the Global Human Resources Management strategy. Based on this strategy, the Hitachi Group recruited human resources to support its global growth and develop its management base.

In 2011, Hitachi was controlled by a 13-member board of whom just four members were notionally independent. In 2012, Hitachi increased the number of independent directors, including non-Japanese directors. Today, our Board of Directors, which is chaired by an independent director, has 13 members, including 10 independent directors, 2 directors who are also serving as executive officers and 1 director who is not serving as an executive officer.

To continually develop innovation and create new value in a global and digital era, Hitachi works on attracting, retaining, and developing diverse talents at a global scale.

To become a world leader in the Social Innovation Business, we believe it is important to maintain high engagement across countries and regions, as well as companies, and establish diverse human capital and a working environment that maximizes personal and organizational performance.

For this reason, Hitachi has composed a Statement on Diversity and Inclusion and strives to create an environment where diverse human capital can exercise its potential to the fullest.

Furthermore, we created a Diversity & Inclusion Development Center that acts as a secretariat managing the Advisory Committee and Diversity Development Council. The Advisory Committee ensures follow-through on our diversity management policy, whilst the Diversity Development Council discusses specific activities and shares best practices. Both meet every six months.

Hitachi's D&I strategy has about a 20-year history, starting with the year 2000's Support for Women's Career Advancement and, since 2012, the pursuing the link between business and diversity.

In April 2021, the company's executive class comprised of 10% female and non-Japanese re-

Hitachi's business vision

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in hardware and other product businesses. I envision fully using Lumada over the next 10 or 20 years to bring about disruptive innovation.

Now, when I decided it was time to switch to Phase 2, we were short of something: an IT team for product innovation. Although we do have a team that brings about operational innovation by conducting system integration, we lack IT resources for the products business, and this impedes innovation. I believe that herein lies the cause of Lumada's insufficient growth in the products business.

GlobalLogic approaches companies that deal in products by offering them the opportunity to achieve significant innovation in their products through the use of digital technologies. Design specialists who consider products from a design perspective make proposals. They relay to prospective clients that, by looking at their products with completely fresh eyes, they can come up with some really amazing things. Next, they carry out customer discussion, upon which they base system development, which they also take on.

This is what GlobalLogic is all about. In essence, they bring about the disruptive innovation of products by using digital or cloud-type technologies. There is currently a tremendous need for this. We hear about the digital transformation of operations. What they are trying to achieve is the digital transformation of products. For Lumada, these skills and resources are important to Lumada's further expansion.

We will bring about the innovation of various products in Hitachi's lineup in order to offer great value. Our image for the next 10 to 20 years is for this happen for railway cars, medical equipment, and everything else".

spectively, representing the achievement of its initial objectives. The number of female managers reached 800 as of October 2020.

In April 2021, Hitachi declared important commitment to further accelerate its diversity and inclusion (D&I) strategy. Vice President and Executive Officer Lorena Dellagiovanna, who also serves as Chief Diversity and Inclusion Officer (CDIO), held an online press conference in which she announced that "Hitachi will aim to achieve 30% of non-Japanese and 30% of female in Executive and Corporate Officers by fiscal year 2030. Over 350,000 employees who are working at Hitachi are unique and diverse, with each of us carrying a huge asset of skills, capabilities, ideas, experience, and values. It is therefore very important to leverage this diversity by implementing a process for behavior change and by creating an environment where people can be themselves. That will bring a huge opportunity for Hitachi to bring innovation, to tackle new markets, to better serve our customer, and to attract new talents".

Dellagiovanna pointed out that "D&I strategy is essential to Hitachi in becoming a global leader". Studies have shown that the promotion of D&I correlates with improved financial performance and that organizational innovation and employee engagement also increase. These are also reasons why investors include the progress of D&I among the factors for making investing decisions.

Dellagiovanna states that "Today, future growth and sustainable business depend on the creation of a vibrant workplace environment, where everyone can express freely their values and ideas to contribute to business".

As a specific example of diversity creating innovation, Dellagiovanna presented Italy's railway system project. In this project, engineers from Japan and Italy overcame language barriers and cooperated in developing a new double-decker car for Italy's public railways.

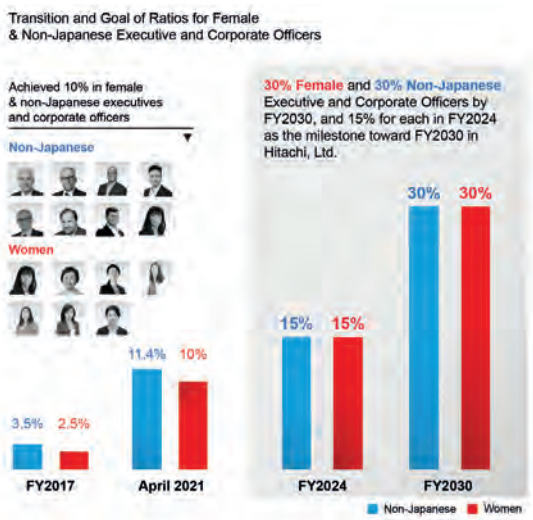
Specific measures for achieving the goal of 30% women and non-Japanese in the executive class by fiscal year 2030 were announced during the press conference.

The general plan is to publish KPIs, monitor progress, and annually disclose results. Also revealed were the following five types of KPIs: (1) leadership commitment, (2) organizational culture, (3) recruitment activities, (4) retention, and (5) promotion to higher positions.

Dellagiovanna said "We will strengthen internal communication strategy to demonstrate leadership commitment. We are also going to run a number of initiatives surrounding corporate culture, including conducting specific surveys and trainings for eliminating bias, and working on how to accelerate talent exchange globally".

ßOnly one thing has not changed over time: Hitachi maintains the philosophy of the spirit inherited from its founder – of contributing to society through the development of superior, original technologies and products. It also continues in its aim of becoming a global leader in the Social Innovation Business, leading the way in achieving the realization of a sustainable society and improving the quality of life for people around the world by increasing value for its corporate customers and valuing collaborative creation worldwide.

Vice President and Executive Officer Lorena Dellagiovanna presenting Hitachi's D&I strategy



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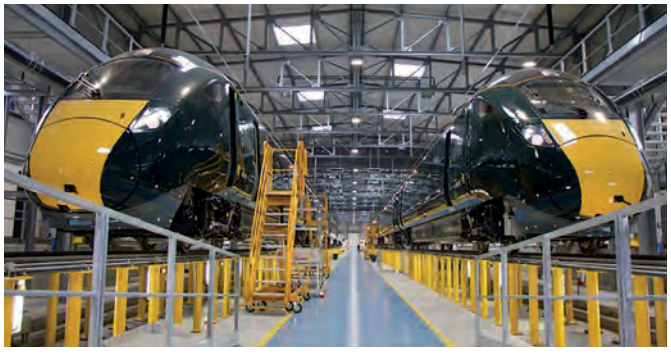
2. HITACHI'S COMMITMENT TO ITALY: MORE THAN JUST A COUNTRY

2.1. Hitachi: a proud Italian company

Hitachi's history in Italy began in 1982, when it entered the Italian market through the establishment of two divisions – one dedicated to electronic components and the other to consumer products. Over time, Hitachi faced the transition from pure commercial trading to production. After a long process of expansion, Italy is now one of Hitachi's most important geographies outside Japan, both in terms of overall economic contribution ($3.4 billion turnover), and direct employees (about 5,000), with 9 production sites, 14 offices and 5 R&D centers.

Hitachi Rail's sites in Naples and Pistoia, Italy



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Hitachi's presence in Italy (8 companies) is characterized by a wide geographical footprint, with a direct presence in 13 Italian regions and multiple business sectors. Hitachi solutions are applied in many business areas, from railways and mobility, through information technology and automation, to water and energy management, as well as healthcare. Among them:

- Hitachi Rail STS, born from the evolution of AnsaldoBreda and Ansaldo STS, is specialized in the construction of rolling stock in the railway and metro sector produced in the sites of Pistoia, Naples and Reggio Calabria.
- Hitachi ABB Power Grids (soon to be "Hitachi Energy") is specialized in providing product, system, software and service solutions across the power value chain, to meet the demand for electricity with minimum environmental impact.
- Hitachi Vantara is specialized in data management solutions that help companies improve the customer experience and enhance their innovative capacity by combining IT (Information Technology), OT (Operational Technology) and industry expertise.
- Hitachi Europe is the local corporate entity with the scope to create synergies among all different business unites, as well as incubating new businesses and leading global pilot projects active on a national level. For example, Hitachi Europe has a dedicated department active in the energy efficiency and water managements fields with end-to-end solutions developed through the co-creation approach in close collaboration with our clients and all the stakeholders involved. In addition, Hitachi Europe provides a cutting edge solution for Particle Beam Therapy (PBT), one of the most advanced type of cancer radiotherapy which uses beam of charged particles.

Hitachi ABB Power Grids site in Lodi, Italy

Source: © Hitachi, Ltd. 2021. All rights reserved.

The intrinsic value of Hitachi lies in the synergies enabled by the co-existence of these many souls, each characterized by a distinctive know-how, highly competitive and innovative in its field, which generate value through an integrated perspective.

The distinctive features of Hitachi, its vision oriented to solve social and environmental problems, its commitment to the creation of an inclusive and harmonious society, and the pervasive adoption of a collaborative approach, make Hitachi a key player in the Italian path towards growth and sustainability. This has contributed and continues to contribute to the realization, also in Italy, of a 5.0 Society.

2.2. Hitachi's investment in Italy: a catalyst for the country's growth

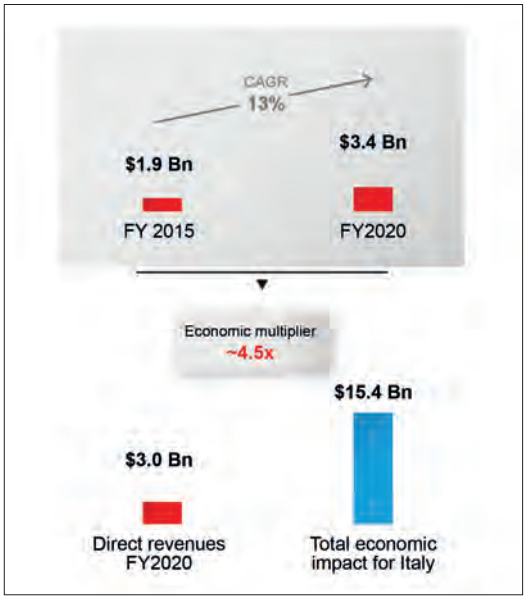
As a true Italian company, Hitachi contributes to the Italian economy through revenues, production value, exports and investments, all of which have been growing steadily since Hitachi's establishment in Italy in 1982.

First of all, Hitachi presents steadily increasing revenues: between 2015 and 2020, we registered a Compound Annual Growth Rate (CAGR) of 13%, going from $1.9 billion to a cumulative value of about $3.4 billion.

Hitachi's economic contribution can be measured not only from a direct point of view, but also from an indirect and induced one, linked to the activation of supply and subcontracting chains. Firstly, each company positions itself in the market with a dual role: buyer of goods and services that it employs in the production process and seller of goods and services to other economic sectors. In addition, the sector contributes to generating added value for its employees: the greater the propensity to consume goods and services, the greater the multiplier effect.

Input-output analysis reveals a significant multiplier effect of Hitachi on the Italian economy. In Italy, for a multiplier effect of 4.5x Hitachi generates total revenues of €13.5 billion, cumulating direct, indirect and induced value. This

Hitachi's Direct, Indirect and Induced Revenues in Italy, USD billion



Source: Hitachi, Ltd. 2021; ISTAT; BCG analysis

means that for every Euro of revenue generated by Hitachi in Italy, 3.5 Euros of additional revenue is generated within the entire Italian economy.

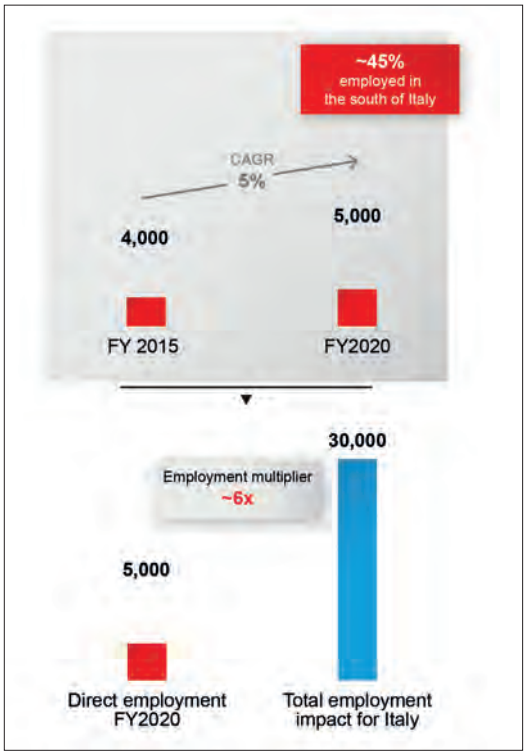
In addition to turnover, exports contribute positively to the Italian balance of trade, leverage the country's distinctive skills and, at the same time, promote the internationalization of the industrial sector.

From a social perspective, Hitachi plays an important role in terms of employment. The Group has progressively increased its total workforce: between 2015 and 2020, the number of employees increased from approx. 4,000 to around 5,000, registering a 5% CAGR, five times the national employment growth rate (+1%).

By investing in the skills of the territories in which it operates, the growth recorded in the period 2015-2020 makes Hitachi one of the main foreign-owned groups for employment growth in Italy.

Hitachi also makes an important contribution to combating regional imbalances, with a well-distributed presence throughout the country and a workforce more concentrated in the South than in the North.

Hitachi's Direct, Indirect and Induced Employees in Italy,



Source: Hitachi, Ltd. 2021; ISTAT; BCG analysis

As with revenues, Hitachi's contribution to employment is not limited to a direct impact, but includes indirect and induced employees resulting from the activation of supply and sub-supply chains and the induced effect on consumption.

Considering Hitachi's supply chain and the characteristics of its workforce, each job generated directly by Hitachi supports 6x the jobs in the entire economy. In light of this, Hitachi's overall contribution to Italian employment amounted to nearly 30,000 people in 2020.

From an innovation perspective, Hitachi has a large portfolio of patents: in 2018, those in force were 247 (217 with national validity and 30 international), with a rate of patents/employees 3 times higher than the national rate – Hitachi has 44.6 patents in force for every 1,000 employees, against an Italian average of 13.6 patents in force for every 1,000 employees.

To mention a few, Hitachi ABB Power Grids developed energy storage and digital automation solutions for energy optimization and manage-

ment, advanced control, and monitoring of distributed energy resources and renewable power sources. Its Transformer Division developed new technologies, materials, designs and manufacturing processes. These aimed to enhance safety, quality and energy efficiency, as well as to lower the environmental footprint of transformers, components and other grid's operation devices over their entire life cycle. Its High Voltage Division developed Hybrid Switchgear, Gas-insulated switchgear, and measurement equipment such as instrument transformers.

This, in addition to demonstrating the high efficiency in translating R&D activities and investments into technological solutions, is a remarkable example of how Hitachi is committed to sustainably investing in Italy, contributing to the development of social capital through cutting-edge R&D activities.

Hitachi's playbook for Italy: a multi-step strategy

Since its establishment in Italy, Hitachi has been characterized as a multi-business operation in diverse fields, from consumers to power plants. The Group's strategy has been to look at new startups or local realities of particular interest to expand its business: from incubation to independence and the creation of a true business unit.

Specifically, a series of crucial acquisitions in the country have defined its presence in Italy and demonstrated the company's willingness to grow and increase the export capacity of Italian companies, both in terms of products and skills.

In 2015, Hitachi Group acquired the majority of the share capital (51%) of Ansaldo STS, a leading company operating in the sector of high technology for railway and urban transport.

Immediately after, Hitachi acquired Ansaldo-Breda, the most important Italian brand with over 160 years of history in the railway and metro sector, which then became Hitachi Rail Italy.

This has elevated Hitachi to a leader in the rail and mass transit market, with a major hub of production activity concentrated in Italy.

More recently, Hitachi Vantara launched in the Italian market to leverage the broad portfolio of innovation, development and experience from across Hitachi Group companies to deliver data-driven solutions for commercial and industrial enterprises. This new company is unifying the operations of Hitachi to capitalize on Hitachi's social innovation capability in both operational technologies (OT) and information technologies (IT).

Lastly, the establishment of Hitachi ABB Power Grids (Hitachi Energy from Oct 2021) will strengthen Hitachi in energy infrastructure with a strong footprint in Italy, by building an energy platform for more efficient use of electricity throughout society.

Thanks to this, the expansion of the Social Innovation Business will be not only in the Power and Energy area, but also in areas such as Mobility (railways and electric vehicles, etc.), Smart Life (smart city and buildings etc.) and Industry (manufacturing facilities and plants, etc.), providing a wide range of customers with innovative energy solutions.

Globally, as in Italy, Hitachi is recognized for its quality and reliability, but also as a player at the forefront of providing technology solutions that meet the needs of individuals and society, contributing to the technological pillar of modern society.

At Hitachi, we are proud of our history and excited about our future in Italy. By collaborating with a range of stakeholders, we strive to provide solutions in Italy that resolve social issues and improve the quality of life for everyone.

3. SUSTAINABILITY: A CORNERSTONE OF HITACHI'S STRATEGY

3.1. Race to Net-Zero: Fast-forward to decisive climate action

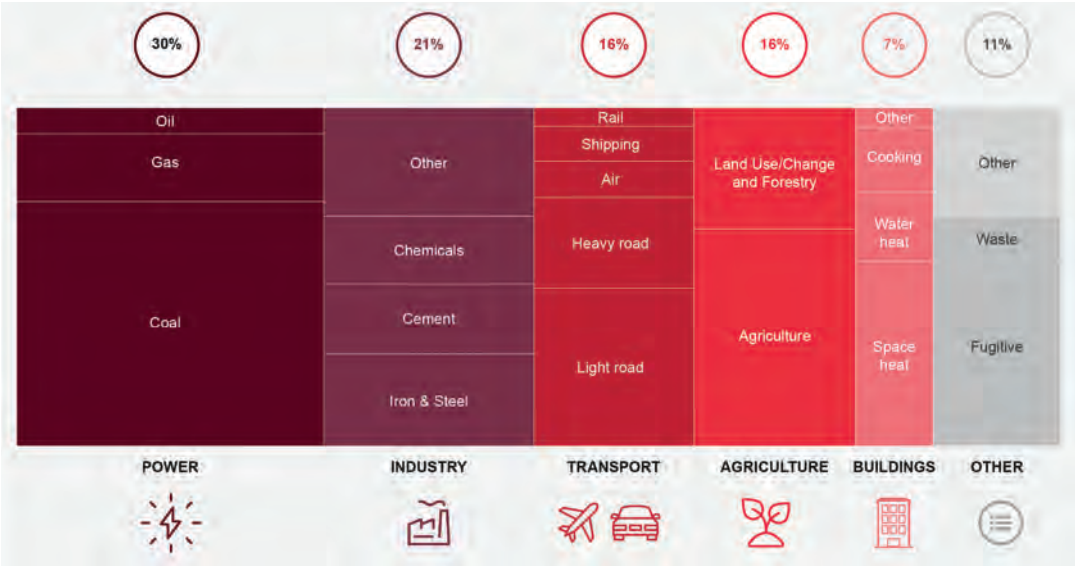
The UN Environment Programme's Emissions Gap Report 2020 found that global greenhouse gas (GHG) emissions hit a new high of 59.1 gigatonnes (Gt) of CO_2 equivalent in 2019.

Over the past decade, emissions have continued to increase at a rate of 1.5% per year, rising in all major economic sectors.

Particularly, a closer look at GHG emissions breakdown by economic sector reveals that:

- Power production today generates the largest share of GHG emissions (30%). Approximately 95% of electricity comes from burning fossil fuels, mostly coal and natural gas.
- Industry represents the second-largest share of GHG emissions (21%), burning fossil fuels for energy, as well as GHG emissions from mineral products (such as cement) and other chemical reactions necessary to produce goods from raw materials.
- The Transportation sector contributes around 16% of global GHG emissions, with road transport being primarily responsible (94% of the sector). Rail, shipping and aviation are relatively smaller, with emissions in international territory being 4% of the total.
- Agriculture contributes 16% of total GHG emissions, with most emissions coming from enteric fermentation (ruminant animals, such as cattle),

Global greenhouse gas (GHG) in gigatonnes (Gt) of CO_2 equivalent at sectoral level



Source: EDGAR, United Nations Framework Convention on Climate Change, Food & Agriculture Organization of the United Nations, I EA, WSA , BCG analysis.

nitrogen fertilizers on agricultural soils, and municipal waste.
- Buildings contribute to 7% of global GHG emissions, arising primarily from fossil fuels burned for heat.

Should this pattern continue, the world is projected to warm by 3°C to 5°C by 2100, which would have catastrophic effects on human civilization.

To prevent this risk, a major turnaround in emissions trajectories is needed in all sectors (reduction of approximately 3-6% per annum between now and 2030) to limit the rise in surface temperatures and avoid disastrous climate change effects.

In 2015, world leaders met in Paris and agreed to limit the global temperature rise by the end of the century to well below 2°C and to pursue efforts to limit the temperature increase even further to 1.5°C.

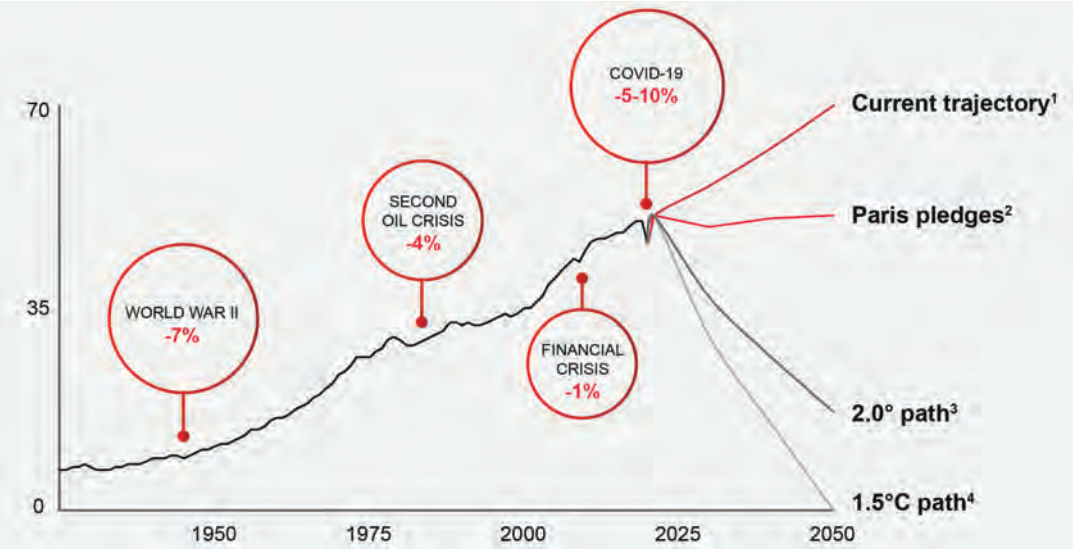
According to the Intergovernmental Panel on Climate Change (IPCC), limiting global warming to 1.5°C requires net human caused carbon dioxide (CO_2) emissions to fall 45% by 2030 and to reach net-zero by 2050. Even limiting the temperature rise to 2°C will need CO_2 emissions to fall by 25% by 2030, requiring a turnaround of the present trend and approximately $75 trillion in investments.

As of today, three major levers exist for reducing global GHG emissions, with many technologies not only readily available, but already highly affordable:

Abate

- Shift the sources of electricity generation to cleaner, renewable technologies such as solar and wind, and support it with improvements in battery storage and the power grid.
- Invest in electric heat, rather than natural gas, when the grid is clean enough to support it.
- Use heat pumps powered by renewable electricity as a partial replacement for natural gas in residential and commercial heating and appliances.
- Increase investment in energy efficiency and demand management to reduce needs.
- Electrify transportation and improve its efficiency, also leveraging new technologies such as hydrogen fuel cells and biofuels, for medium- and heavy-duty vehicles. At the same time, invest in infrastructure such as public transit and freight and passenger rail.

Global greenhouse gas (GHG) in gigatonnes (Gt) of CO_2 equivalent



1 Assumes GHG emissions grow from 2018 at same rate as the Current Policies scenario in UNEP 2019 Gap report to 2050 (1.1% CAGR).
2 Assumes countries decarbonise further at same annual rate that was required to achieve their INDCs between 2020 and 2030.
3 Assumes 25% reduction by 2030 and net-zero by 2070.
4 Assumes 45% red uction by 2030 and net-zero by 2050.
Note: exclude LULUCF = Land use, land use change and forestry.

Source: EDGAR 5.0; FAO; PRIMAP hist v2.1; Global Carbon Project; IPCC; UNEP Emissions Gap Report; WRI; BCG analysis.

- Optimize and gradually decarbonise industrial processes by increasing efficiency, changing feedstock, and using green hydrogen (in steel production, for example).

Capture

- Capture emissions at the source for use in other applications (such as chemical feedstock) or placement in long-term storage. Carbon capture and storage technology is becoming more mature and economically viable, and a healthy and increasing pipeline of projects in the US offers significant opportunities for industry.

Remove

- Use technologies such as biochar and direct air capture to remove emitted CO_2 from the atmosphere, and support nature-based solutions such as carbon sequestration, reforestation, and ocean fertilization. Some of these technologies exist today, but many remain subscale and require further development before they can have a meaningful impact.

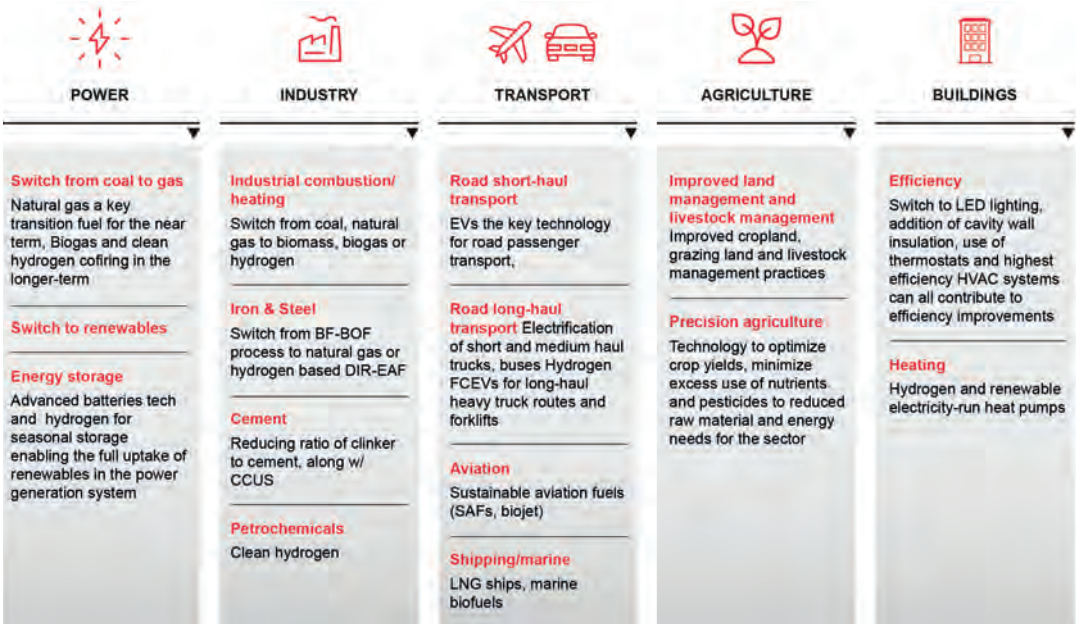
In particular, according to a recent study published by Goldman Sachs, 35% of the decarbonisation of global GHG emissions is reliant on access to clean power generation. Renewable power is vital, and nonetheless, renewable energy technologies have experienced >70% deflation over the past decade. As the second-most scalable (and complementary) technology, clean hydrogen could unlock decarbonisation in some of the harder-to-abate sectors making up 20% of global GHG emissions. This includes long-haul transport (trucks), seasonal storage that enables the full uptake of renewables in power generation, high-temperature heat for industrial combustion and other industrial applications (such as iron & steel, petrochemicals), heating for buildings, and more.

As more technologies reach commercial scale, about 85% of anthropogenic global GHG emissions can be reduced today (vs. 75% estimated in 2019). However, as mentioned, progress on climate action to date has been limited.

On the government side, while 121 countries have now committed to being carbon neutral by 2050, they account for less than 25% of emissions. None of these countries are among the top five emitters, and few, despite the commitment, have enacted policies that are robust enough to produce the desired effects.

Specifically, of the 121 countries with net-zero goals, only 7 have broken this target down into intermediate sector-level targets/roadmaps and have policies in place that could realistically trigger the reductions. Although these 7 help lead the

Several available decarbonisation technologies across sectors to lower GHG emissions



Source: Goldman Sachs – Carbonomics, October 2020; BCG analysis.

way for others, their combined GHG emissions account for less than 2% of the world's total.

On the corporate side, of the millions of corporations worldwide, only about 7,000 disclose their climate-related data. Of those, only a third provide full disclosure, a quarter set any type of emission reduction target in line with the Paris Agreement trajectory, and an eighth actually reduce their emissions year-on-year.

The lack of common reporting standards makes it hard to compare targets, and the lack of transparency makes it too easy for companies to display policies that are mostly window dressing instead of actually investing in meaningful emission reductions.

Investors can coordinate to define and apply standards for disclosure and reporting. In fact, they have started to put pressure on companies to better understand and disclose their carbon-related risks and develop resilience strategies – individually or through activist groups.

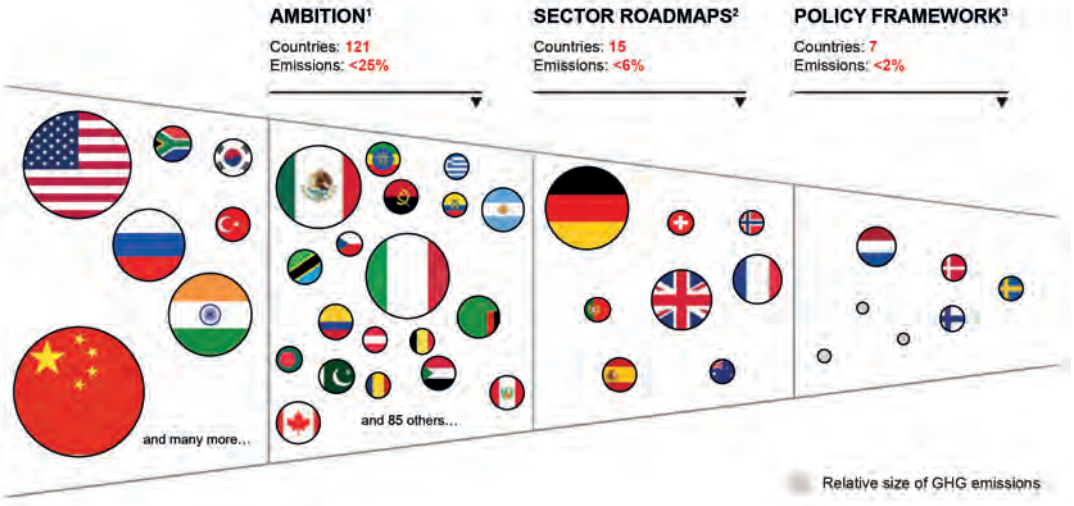
Even more importantly, investors can increase scrutiny on long-term climate risks and put more capital into green financing vehicles, encouraging asset managers to set long-term targets and strategies towards net-zero emissions.

For example, the UN-convened Net-Zero Asset Owner Alliance has brought together investors managing a total of $4 trillion in assets. They have committed to transitioning their portfolios to net-zero emissions by 2050. Bank of America has committed to invest an additional $300 billion in capital by 2030 in sustainable energy and transportation, climate resiliency and clean water. Santander aims to facilitate €220 billion of financing linked to the Sustainable Development Goals by 2030 with an emphasis on green finance, all with the aim to support the transition towards a low-carbon, sustainable economy and enable it to deliver long-term value.

It is clear that the world needs cohesive and swift global policy action. Progress is urgently needed at COP26 this year, which is expected to bring a meaningful international response to the climate crisis.

Most importantly, the response must build on each other's efforts over a long-term horizon. Individual governments and corporations can and should move ahead with unilateral initiatives. Whilst no single actor can halt global warming, efforts by leading industrial nations or large corporations can have a multiplier effect.

Only a few countries have a roadmap and robust policies to deliver net-zero ambition



1 Countries with a net-zero ambition.
2 Ambition translated into sector roadmaps with targets.
3 Targets supported by an effective policy framework.

Note: Countries with emissions >40 million tonnes and those with emissions >75 million tonnes with a net-zero ambition are represented graphically by a flag.

Source: Emissions data from CAIT (from the World Resources Institute) and Eurostat; Policy analysis by BCG, referencing the IMF, Climate Action tracker and government websites; BCG analysis.

COP26 is the 2021 United Nations climate change conference

For nearly three decades the UN has been bringing together almost every country on earth for global climate summits – called COPs – which stands for "Conference of the Parties". In that time climate change has gone from being a fringe issue to a global priority.

This year will be the 26th annual summit – giving it the name COP26. With the UK as President, COP26 takes place in November in Glasgow, Scotland.

Many believe COP26 will be the world's best last chance to get runaway climate change under control. In fact, in the run up to COP26 the UK is working with every nation to reach agreement on how to tackle climate change. More than 190 world leaders will arrive in Scotland. Joining them will be tens of thousands of negotiators, government representatives, businesses and citizens for twelve days of talks and update on plans for reducing emissions.

In partnership with the UK, Italy will host this September in Milan the Pre-COP as a preparatory meeting for COP26, with the aim of bringing together ministers from a representative group of countries to discuss and exchange views on key political aspects of the negotiations, to find solutions to outstanding issues and set the tone for COP26.

COP26 Goals:

- **Secure Global Net-Zero by midcentury and keep 1.5 degrees within reach**

Countries are being asked to come forward with ambitious 2030 emissions reductions targets that align with reaching net-zero by the middle of the century. To deliver on these stretching targets, countries will need to accelerate the phaseout of coal, encourage investment in renewables, curtail deforestation and speed up the switch to electric vehicles.

- **Work together to deliver**

We can only rise to the challenges of climate change by working together. At COP26 we must finalise the Paris Rulebook (the rules needed to implement the Paris Agreement). And, we have to turn our ambitions into action by accelerating collaboration between governments, businesses and civil society to deliver on our climate goals faster.

- **Mobilise Finance**

To realise our first two goals, developed countries must deliver on their promise to raise at least $100 billion in climate finance per year. International financial institutions must play their part and we need to work towards unleashing the trillions in private and public sector finance required to secure global net-zero.

- **Adapt to protect communities and natural habitats**

The climate is already changing, and it will continue to change even as we reduce emissions, with devastating effects. At COP26 we need to work together to enable and encourage countries affected by climate change to protect and restore ecosystems, build defenses, put warning systems in place and make infrastructure and agriculture more resilient to avoid loss of homes, livelihoods and lives.

COP26 principal partners:

Corporates need three major levers to tackle climate change

Source: World Economic Forum in collaboration with Boston Consulting Group – The Net-Zero Challenge: Fast-Forward to Decisive Climate Action, January 2020.

In particular, this momentum is driven by companies' determination to play their part in stopping global climate change, as well as an understanding of the competitive advantages to be gained.

Even today, companies can – and should – do a lot more individually to decrease their emissions. Companies are no longer being asked about how they plan to take responsibility for last year's emissions alone, but also their long-term transitions to becoming net-zero businesses, their contribution to securing a net-zero economy writ large, and the appropriate role for nature-based solutions both inside and outside of their value chains.

This is mainly about companies managing risks, preparing for anticipated changes in regulations and preparing their business models for a low-carbon future.

To do so, they can accelerate individual action and commit to meaningful short and long-term reductions.

Most can develop new business models that contribute to achieving a low-carbon economy and capitalize on the new value pools for "green" products and services.

Across all sectors, three major levers can enable corporates to radically reduce their emissions and prepare for a decarbonised world, gaining a competitive advantage in the shift to a greener economy.

As a first step, companies should begin by mitigating GHG emissions throughout their value chain.

Following the Greenhouse Gas Protocol Corporate Accounting and Reporting Standard, emissions are typically split into three scopes:

- Scope 1 covers the emissions from operations under a facility's control, including onsite fuel combustion.
- Scope 2 covers the emissions from usage of electricity, steam, heat and/or cooling purchased from third parties.
- Scope 3 covers upstream and downstream value chain emissions, including procured products, transport of suppliers and business travel, usage of sold products and product disposal[1].

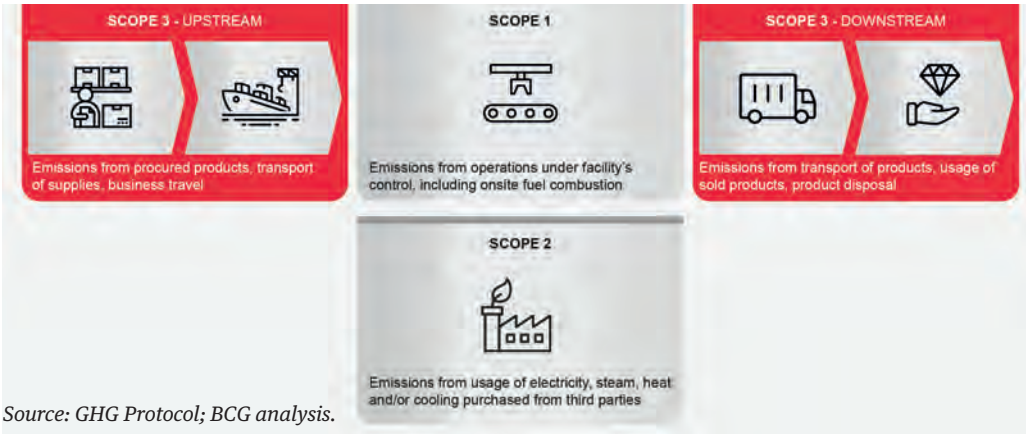
By accelerating the switch to renewable energy, improving energy and process efficiency in their operations, and leveraging their buying power to ensure that their suppliers decarbonise, most companies can help mobilize the overall decarbonisation of the economy, significantly reducing their emissions and those of their partners.

Design choices can help bring down supply-chain emissions. Companies can design products for sustainability by using greener materials, cutting waste, reducing product variance, increasing recyclability, improving repairability and switching manufacturing processes to lower-carbon ones.

However, by engaging suppliers to create a net-zero supply chain, companies can multiply their climate impact. Upstream-Downstream emissions (Scope 3) are much higher than the direct

1 CDP estimates that the Scope 3 emissions are on average four times higher than the direct emissions of the companies that report to them – CDP is a not-for-profit organization that supports companies to disclose their environmental and climate impacts; in 2018, nearly 7,000 companies answered CDP questionnaires, disclosing data on emissions and their broader approach to climate change.

Scope of GHG emissions by Greenhouse Gas Protocol Corporate Accounting and Reporting Standard



Source: GHG Protocol; BCG analysis.

emissions in their own operations (Scope 1 and 2 emissions).

Companies can set standards for suppliers or require suppliers to set standards, and work directly with them on joint decarbonisation initiatives such as de-carb education, technical support and methodology sharing.

As a second and third step, they can de-risk their asset base and start the transformation of their business models with strong positive business cases and shareholder return stories.

Companies can indeed drive innovation to create new solutions, and accelerate progress by offering low-carbon products and services, involving willing consumers in their decarbonisation journey. Even in the harder-to-abate sectors, companies can turn a first-mover disadvantage into an opportunity.

In the wake of growing global consciousness about the climate crisis and consumers' desire to limit the impact of their consumption footprint, a wide range of new markets for lower-carbon solutions are taking shape. Digital technologies are key enablers: large-scale or decentralized renewables, advanced mobility and new fuels, energy efficiency solutions, circular economy business models, carbon capture usage and storage (CCUS), and hydrogen technologies.

Therefore, companies can engage consciously and constructively on how to reach nature positive, including its biodiversity and societal values by offering consumers a "green choice" or by innovating to help customers bring down their own emissions.

It goes without saying that companies that successfully integrate an effective climate response into their core business strategy will be able to generate value. We're seeing corporate leaders respond to the climate challenge in a way that helps reduce costs, grow their business, or capture price premiums, as well as maintain or extend their license to operate.

Nevertheless, companies with lower emission intensities are traded at higher valuation multiples on stock markets. A recent BCG analysis across a range of high-emission industries found that top-quartile companies in specific ESG metrics trade at a premium vs the industry median.

Acting on climate is not only a responsibility, but also a source of competitive advantage in their respective sectors – in terms of reducing cost, fulfilling the needs of future customers, and attracting the greatest possible talent.

Ultimately, time has run out. The costs of natural disasters are on the rise. More frequent droughts are already hurting agricultural productivity even in mild regions such as Central Europe. Ice sheets in West Antarctica and Greenland are starting to collapse. Wildfires and extreme weather events are increasing at

unprecedented rates. If unchecked warming continues, the consequences for human civilization will be severe.

Past inaction has dramatically increased the pace at which the world needs to decrease emissions. Complying with 1.5-2°C pathways would require drastically reducing emissions in the next decade.

The need for action is immediate. While existing technologies can decarbonise most emissions, in certain high-emitting sectors in industry and transport, decarbonisation costs will remain high. These sectors account for approximately 20% of global emissions and will require a joint effort to overcome existing transformation barriers too high for individual companies to bear alone.

Alongside carbon pricing, sector-specific government regulations and incentives would promote remedies such as a switch from fossil fuels to renewable energies, electric mobility, efficiency, green building standards. Through cooperation in coalitions, companies can share the risks of technology development and coordinate related investments in the development of low-carbon technology solutions.

It is within everyone's power and responsibility to act to encourage the decisive acceleration of climate action. All stakeholders – corporations, governments, investors and, ultimately, individuals – can take unilateral initiative to lower emissions, often with positive economic implications.

However, voluntary action and unregulated markets will not deliver that shift. Governments need to step in to drive the change. Cohesive multilateral policy coordination would be the best solution for halting the climate crisis. Decisive progress is therefore needed at COP26 in Glasgow in late 2021. In the end, the world needs urgent action at every level to change the trajectory of ever-increasing emissions. Considering the facts, it should be viewed as an opportunity for businesses, countries and individuals to create an advantage in building a better, more sustainable world.

3.2. Hitachi's global Sustainability Agenda

To address the variety of global societal and environmental challenges, the United Nations formulated a set of Sustainable Development Goals (SDGs), published in 2015 in its 2030 Agenda for Sustainable Development. These consist of 17 goals and 169 targets to be achieved by 2030 in order to bring about global sustainability. The Paris Agreement on climate change was also adopted in the same year as the SDGs and was ratified the year after.

These developments have led to growing activity in the field of "Environment, Society, and Governance" (ESG) investment.

Corporate trends in Sustainability

Based on its Corporate Credo and Pioneering Spirit, Hitachi has forthrightly engaged in its Social Innovation Business, which combines the company's three strengths in operational technology (OT), information technology (IT), and products and systems. Today, it responds to the challenges faced by society to contribute to improving people's quality of life and to creating a sustainable society.

The diversity of the businesses means that Hitachi can contribute to achieving the SDGs across a wide range of areas. In FY2017, Hitachi launched its Executive Sustainability Committee chaired by the President and CEO to look at the relationships between the 17 SDGs and the management and operations of Hitachi. The committee identified 5 of the 17 SDGs that Hitachi could make a major contribution to achieving through its business strategy. It also identified a further 6 SDGs as targets to which Hitachi could contribute through company-wide business activity.

With regard to the relationships between business and the SDGs, Hitachi established a Sustainability Promotion Meeting that deliberated during FY2017 and FY2018 and included representatives from the business planning departments at each of the business units and key Group companies.

Specifically, the committee determined how Hitachi's main businesses could contribute particularly to SDGs 3, 6, 7, 9, and 11, these having been identified as Hitachi's Business Strategy.

The committee also highlighted the potential negative impacts of business on society and the environment and what can be done about them. The following sections describe some of the ways Hitachi is making progress towards these goals.

Contribution to Good Health and Well-being (Goal 3)

Healthcare is an essential part of the infrastructure that underpins society, and Hitachi recognizes a need for the development of next-generation systems that provide people everywhere with access to smart, universal healthcare. Social innovation and digitalisation in healthcare will play a key role in achieving this goal.

The sophisticated analytical techniques that have linked together the Internet of Things (IoT), can deliver medical innovations to support next-generation healthcare with excellent cost-benefit performance.

Relationship between SDGs and the Management and Operations of Hitachi

Source: © Hitachi, Ltd. 2021. All rights reserved.

In addition to medical equipment like Particle Beam Therapy (PBT) systems which today support cancer treatment for 80,000 people worldwide, Hitachi offers smart operating rooms, healthcare information systems, and other products and services utilizing IT and AI for more efficient diagnosis and treatment. By advancing our efforts in these areas, we help to make consultations and treatment more effective and improve the patient's quality of life.

Hitachi's contribution to Good Health and Well-being (Goal 3)

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Contribution to Clean Water and Sanitation (Goal 6)

Water is essential to people's life in society, with activities such as water distribution, treatment, and management playing important roles. Hitachi has been involved in the water infrastructure business for many years, developing sustainable water infrastructure in collaboration with the public and private sectors. This includes water and sewage system operators, so that water infrastructure operates efficiently, and the appropriate use is made of water resources, providing 70 million people/day worldwide with access to water that is safe and trusted.

Hitachi's contribution to Clean Water and Sanitation (Goal 6)

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Combining both OT systems for monitoring and controlling water treatment facilities, managing their operation, and IT systems for operating regional water services using analytical techniques, Hitachi supplies total solutions for water and the environment, including such critical infrastructure as water and sewage treatment plants and equipment for water recycling.

Contribution to Affordable and Clean Energy (Goal 7)

In response to the shifting paradigm of the energy market, Hitachi offers grid solutions that help stabilize the energy supply, service solutions that contribute to stable operations and improved operating efficiency, and a broad array of region-specific solutions as renewables become the main sources of the power supply.

Hitachi currently manages 25% of the world's transformer substations and supplies 1.8 billion people with stable energy such as electricity. This contributes to efficient energy utilization by society as a whole, integrating the strengths in operational technology (OT), IT, and products, as well as Lumada IoT Platform.

Hitachi's contribution to Affordable and Clean Energy (Goal 7)

Source: © Hitachi, Ltd. 2021. All rights reserved.

Contribution to Industry, Innovation and Infrastructure (Goal 9)

Evidence of digitalization advancing with unprecedented speed is visible in many industrial sectors.

Industry is utilizing the IoT, big data, and artificial intelligence (AI) to transform itself into a more efficient and sustainable form. Hitachi is one of only a small number of global companies that combines OT and IT. Hitachi is helping to resolve the challenges faced by customers by pursuing things like smart manufacturing. This includes taking on mass customization, drawing on its strengths in the OT used in the workplace, as well as meeting customer needs, the IT that analyses and utilizes data to support business management, and the products that support these activities.

Hitachi's contribution to Industry, Innovation and Infrastructure (Goal 9)

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Contribution to Sustainable Cities and Communities (Goal 11)

Hitachi believes that transportation systems play an extremely important role in the development of all cities. Recognizing that people's way of life can be enriched by enhancing transportation systems and improving connectivity, the company engages in collaborative creation with customers and other partners to bring this about.

As a systems integrator, serving all aspects of railways for 18.5 billion people (both metro and railway line users), Hitachi helps people connect with one another. Hitachi contributes to the revitalization of communities and the development of cities by supplying innovative railway solutions that are safe and highly reliable, utilizing advanced information and control technologies. These include highspeed rolling stock, technology for autonomous operation, and preventive maintenance. In the case of road transportation, Hitachi has prioritized accident prevention and the electrification of automobiles, seeking to deliver safety improvements and ride comfort, alleviate congestion, and reduce the load on the environment.

Hitachi's contribution to Sustainable Cities and Communities (Goal 11)

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The SDGs, to which Hitachi contributes across all of its corporate activities, were identified mainly through discussions with those departments that deal with corporate functions such as human resources, procurement, quality assurance, compliance, and the environmental department.

In the case of **Quality Education (Goal 4)**, for example, Hitachi runs the Hitachi Young Leaders Initiative (HYLI) as an education program for training the next generation of leaders. It provides a venue for students chosen from eight Asian nations, comprising of Japan and seven Association of Southeast Asian Nations (ASEAN) members, to debate the challenges facing regional and international society. It includes people from many walks of life, including business leaders, academic researchers, and representatives of national governments and nongovernmental organizations (NGOs). More than 300 young people have participated in HYLI since it was launched in 1996 and Hitachi is using this initiative to contribute to fostering Asia's next generation.

For **Gender Equality (Goal 5)**, since 2000 Hitachi has been holding the annual Support for Women's Career Advancement and, since 2012, pursuing the link between business and diversity.

The program enabled participants to gain insights and learn new things, including panel discussions involving female leaders from Hitachi Group representing their respective regions, and workshops in which participants held discussions with outside experts.

Moreover, Hitachi is accelerating its diversity and inclusion (D&I) strategy to achieve 30% of non-Japanese and 30% of female in Executive and Corporate Officers by fiscal year 2030.

Hitachi's contribution to **Responsible Consumption and Production (Goal 12)** involves engaging in corporate social responsibility (CSR), monitoring (self-inspection), and conducting regular CSR audits. Therefore, there is an evaluation of the associated risks and challenges, and confirmation that suppliers are complying with guidelines, allowing for ongoing improvements to its supply chain. Hitachi also carries out appropriate management by routinely acquiring, via systems, information from suppliers about the chemicals contained in products.

International initiatives participated by Hitachi

	United Nations Global Compact Officially became a participant in 2009. Joined workshops organized by the Global Compact Network Japan on six different topics, including supply chain management, ESG, and SDGs, in fiscal 2019
wbcsd	**World Business Council for Sustainable Development (WBCSD)** Became a member in 1995
TCFD	**Task Force on Climate – related Financial Disclosure(TCFD)** Announced its support for TCFD in 2018 and disclosed climate–related information based on the TCFD Recommendations
JAPAN CLIMATE INITIATIVE	**Japan Climate Initiative (JCI)** Became a member in 2018
BSR	**Business for Social Responsibility (BSR)** Became a member in 2007, participating in the Human Rights Working Group (HRWG) since 2016
	Tokyo Zero–emission Innovation Bay Participated in council, founded in 2020, as an organizer

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As part of this, to play its proper role as a global corporation, Hitachi actively participates in international initiatives addressing social issues on a global scale.

Sustainability considerations, including the SDGs and ESG factors, are all included in the 2021 Hitachi's Mid-term Management Plan. The Plan also includes several examples showing what constitutes social and environmental value for Hitachi, to provide more information in the future about these forms of value that are created through Hitachi's different business activities.

Based on its corporate mission that has remained the same since it was first established, Hitachi has adopted the phrase "Powering Good" to express its focus: through its Social Innovation Business, Hitachi intends to devote itself to "doing good", namely improving QoL and building a sustainable society – outcomes that will be welcomed by people everywhere. By pursuing this policy of "Powering Good" through its Social Innovation Business, Hitachi hopes to work with customers to make the world a brighter place.

3.3. Hitachi's commitment to carbon neutrality: going beyond the pledge

In relation to **Climate Action (Goal 13)**, in September 2016 Hitachi established its Environmental Vision. This was in response to the 2015 adoption of the Paris Agreement on climate change and the UN's Sustainable Development Goals (SDGs).

The Environmental Vision states that "Hitachi will resolve environmental issues and achieve both a higher quality of life and a sustainable society through its Social Innovation Business in collaborative creation with its stakeholders". To uphold this vision and work toward achieving a decarbonized, resource efficient society, which is harmonised with nature, Hitachi established a set of long-term environmental targets. Called Hitachi Environmental Innovation 2050, these look towards 2030 and 2050 and promote Group-wide environmental activities in line with the Environmental Action Plan, which is updated every three years.

The implementation of the Environmental Action Plan for 2021, covering FY2019-2021 and formulated in line with the 2021 Mid-term Management Plan, is currently underway. Hitachi is steadily accumulating achievements as it works to meet the detailed KPIs that the plan includes.

Specifically, in February 2021 we announced the following ambitious CO_2 reduction targets:

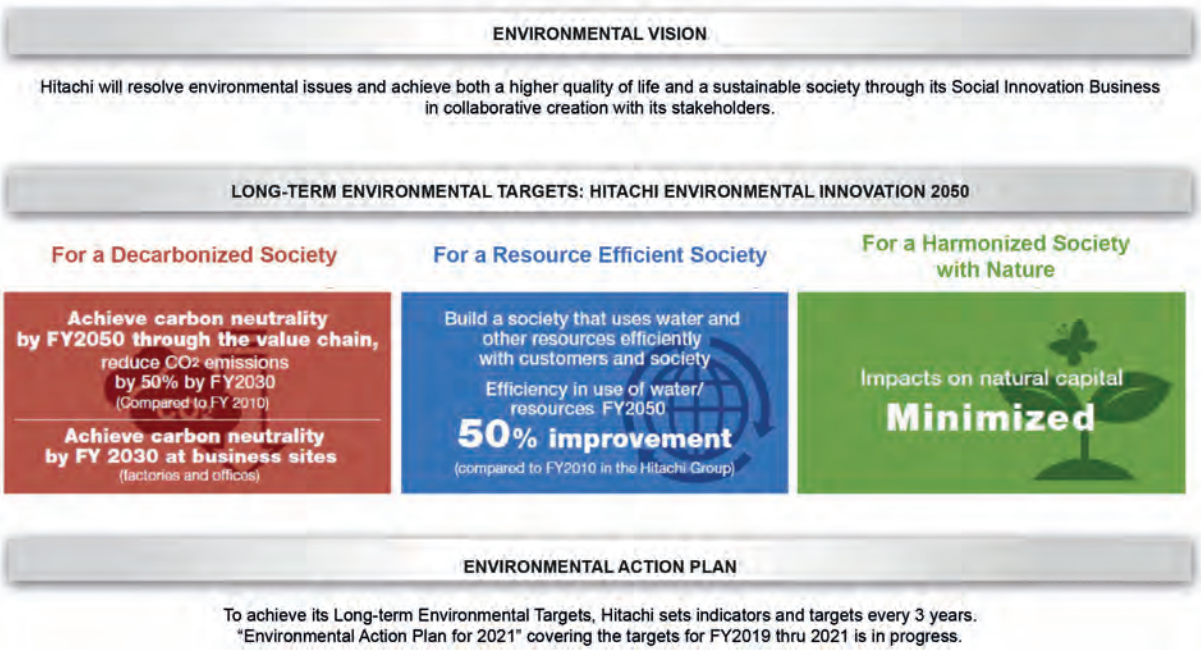
- We intend to achieve carbon neutrality, which will mean net-zero emissions, at all our business sites (factories and offices) by FY2030.
- We intend to achieve a CO_2 emission reduction of 50% by FY2030 (relative to FY2010) through our value chain, and of 80% by FY2050. On this, we pushed our ambition even higher, making a new announcement in September 2021 stating that we intend to achieve carbon neutrality along our value chain by FY2050 to contribute to a net zero society.
- We intend to improve the efficiency of water and other resource use by 50% by FY2050 (relative to FY2010) to help achieve high levels of recycling in society.
- We seek to minimize the impact on natural capital so that society can coexist with nature.

Executive Vice President and Executive Officer Alistair Dormer presenting Hitachi's Environmental strategy

Additionally, Hitachi supports the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD) and is actively advancing its efforts to clarify and disclose information on climate-related risks and opportunities.

Ways of reducing CO_2 emissions during the production stage include making production at factories and offices more efficient, promoting energy efficiency, and making greater use of renewable energy.

Vice President and Executive Officer, Alistair Dormer, who also serves as Chief Environmental Officer, pointed out: "Hitachi has a history of efforts to reduce CO_2 emissions. The company invested 50 billion yen in energy-saving measures over the 10-year period from FY2011 to 2020. By introducing new equipment and optimizing operating conditions, Hitachi achieved a 17% reduction in CO_2 emissions from FY2010 to 4.37 million tons in 2019. And, in 2020, three sites achieved carbon neutrality: Hitachi High-Tech Kyushu Corporation, Hitachi High-Tech Fine Systems Corporation, and Hitachi High-Tech Science Corporation. The Hi-



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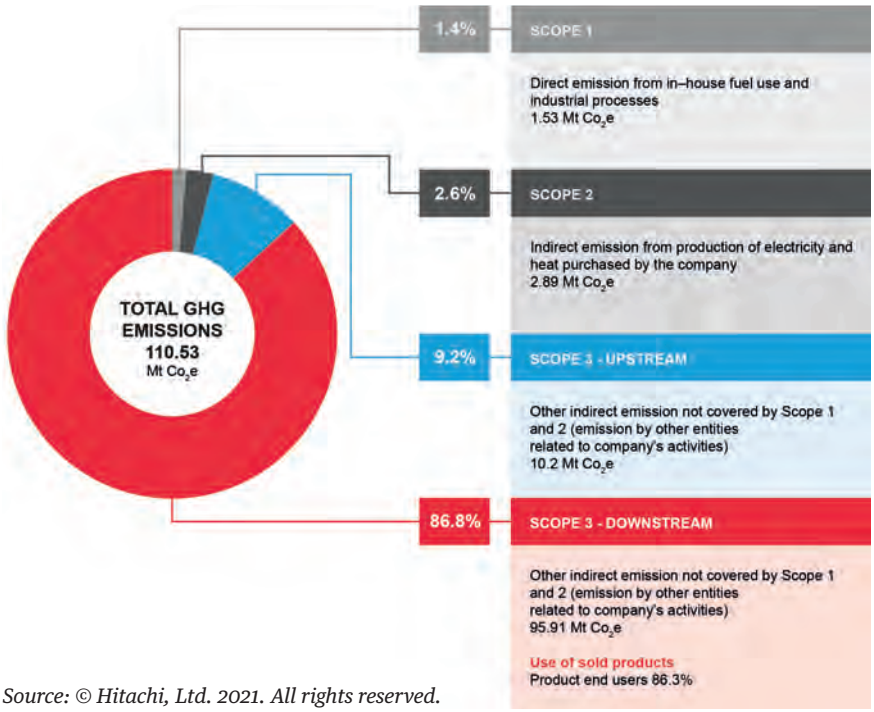
Hitachi's GHG Emissions Throughout the Value Chain, FY2019



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tachi Carbon Neutrality 2030, which sets out the plan through to 2030, prescribes a total investment of 84 billion yen (excluding listed subsidiaries). 60 billion yen of that will be invested in internal facilities, with the remaining 24 billion yen going to renewable energy from outside the company."

Specifically, in the case of factories, Hitachi is working on increasing plant utilization by installing and upgrading highly efficient equipment, and on utilizing the Internet of Things (IoT) to make energy use more efficient, such as by installing smart meters.

In offices, Hitachi is constructing new buildings with high energy efficiency and consolidating and integrating existing facilities. Other initiatives include the adoption of the Hitachi internal carbon pricing (HICP) scheme to encourage investment in energy efficiency improvement and greater use of renewable energy.

Concerning renewables, Hitachi is making purchases from external suppliers and installing photovoltaic power generation systems at its own factories, offices, and other facilities.

At Omika Works, for example, we installed 940 kW of photovoltaic panels and 4.2 MWh of battery storage to make greater use of renewable energy. Also, in the plant of Potenza (Italy), a pilot project is underway to install photovoltaic panels to produce 60% of the total energy needed.

However, a calculation of CO_2 emissions across Hitachi's entire value chain shows that approximately 90% of value-chain emissions result from the use of our products and services after they are sold.

Reducing these emissions will be therefore crucial to reducing CO_2 emissions across the value chain, which encompasses all stages, from the procurement of raw materials and parts to production, transportation, use, disposal, and recycling.

In this sense, Hitachi intends to speed up carbon neutrality by providing solutions that reduce the environmental impact. As Hitachi's business includes many products and services that consume substantial amounts of energy during use, the key to achieving the target lies in reducing CO_2 emissions in the use of these products – by making them more energy efficient or by switching to new alternatives that deliver the same level of value as the past.

To do so, Hitachi is seeking to expand its low-carbon business by supplying solutions in the five areas where its activities are focused, including energy, mobility, smart life, industry, and IT.

- In the energy sector, this involves the supply of energy systems that are based on renewables and other forms of energy that do not derive from fossil fuels, and the implementation of smart grids with benefits that include more efficient and reliable electricity transmission and distribution.
- Moreover, in April 2021, Hitachi ABB Power Grids launched EconiQ™, the eco-efficient portfolio for sustainability that is proven to deliver superior environmental performance compared to a conventional solution. In particular, the High Voltage Products business announced the use of a game changing alternative insulation gas for high voltage equipment, accelerating the adoption of an eco-efficient industry-standard solution to sulfur hexaflu-

oride (SF_6): the EconiQ high voltage portfolio contains no SF_6, eliminates CO_2 equivalent emissions related to the insulation gas and has been proven to significantly reduce the carbon throughout the total lifecycle.

- In terms of mobility, Hitachi is promoting the production with recyclable material, the weight reduction of railway cars, and efficiency improvements via the traffic management system. The first aspect, in particular, has been observed by Hitachi Rail for a long time. For many years trains, tramways and metros made by Hitachi are manufactured selecting raw materials and components that, at the end of life usage, can easily be recycled and reused. The percentages of recyclability in the Italian site of Pistoia are ranging from 90% to 97%.
  The ETR1000 Frecciarossa possesses these characteristics, but the same applies to the high-frequency train, the "Rock" regional train and also to the single deck HMU (Hybrid Multiple Unit, i.e. hybrid train with multiple propulsion, both diesel and electric).
- In the automotive sector, Hitachi is seeking to make transportation more energy efficient by boosting uptake of the electric power trains used in electric vehicles (EVs) and other products.
- In the smart life sector, Hitachi is aiming to make cities more efficient by working on total solutions for buildings that improve all aspects of their efficiency.
- In IT, Hitachi is helping to reduce energy consumption by supplying innovative digital solutions, such as the use of Lumada, and enhancing the efficiency of different systems used in society.

Hitachi set a target for FY2019 of 19% reduction in CO_2 emissions per unit from products and services compared to the base year of FY2010, and our actual rate of reduction in FY2019 was 19%[2].

We decided to push further our Environmental Action Plan to achieve carbon neutrality, which will mean net-zero emissions, across our entire value chain by FY2050.

We firmly believe that, by consistently hitting the targets set in successive environmental action plans and by engaging in low-carbon businesses through the Social Innovation Business, Hitachi will achieve its long-term environmental targets and contribute to creating a low-carbon society.

2 This is due to an increase in sales of high energy-saving products, including industrial equipment and equipment used for social infrastructure.

Decarbonisation Business: A Hitachi Focus

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Interview to Lorena Dellagiovanna, Chief Diversity and Inclusion (D&I) Officer, Deputy Chief Environmental Officer and Deputy General Manager of Government and External Relations Group of Hitachi, Ltd., July 2021

Since 1910, Hitachi has been striving to contribute to society with its technologies and products. Nowadays, sustainability has become of paramount importance for society: how is Hitachi meeting this challenge?

Sustainability has been at the core of Hitachi's strategy since the very beginning.

The company has, in fact, taken a socially responsible approach to business since its establishment in 1910, when our Founder defined the company's corporate mission to "contribute to society through the development of superior, original technology and products".

Now, more than 110 years later, Hitachi's original philosophy remains a good fit with the way we run our business today. As a Deputy Chief Environment Officer, I am proud to say that Hitachi can play a major role to support the decarbonisation, thanks to its advanced technologies and restless pioneering spirits.

I see it as my role to ensure that we become climate change innovators to reduce carbon for governments, cities and our customers. I am honored to drive Hitachi's Environmental Vision which states that we will "resolve environmental issues and achieve both a higher quality of life and a sustainable society, in collaborative creation with stakeholders". One of my duty is to ensure that we become climate change innovators. Hitachi has several long-term environmental targets, including our ambition to become carbon neutral in all our business sites by 2030 and across our value chain by 2050. Our plan has been recently endorsed by Science Based Targets – the 'Gold standard' for accreditation – and we are part of the UN's Race to Zero campaign. What is important to point out is that, if we aim at achieving decarbonisation, we cannot do this alone, nobody could. We need to bring together different thinkers to create innovation outcomes. Our approach is to work side by side with our customers and partners through a process we call co-creation. We work together, to understand deeply what our customers really need, and then develop together different solutions. Because if we are going to achieve decarbonisation – we need to bring together different thinkers and doers to create innovative outcomes.

Hitachi is Principal Partner of COP26, which is going to set the agenda of the fight against climate change for years to come. Why is it so important to your organization to support this conference?

I am proud that Hitachi is a Principal Partner for COP26: this is set to be a momentous occasion, not just in Britain but across the world.

We are proud to be playing our part alongside the UK Government as countries come together to accelerate action towards the goals of the Paris Agreement and the UN Framework Convention on Climate Change.

This event is crucial for us because Hitachi's business strategy is to be a global leader through its Social Innovation Business and to run the business in a way that prioritizes social, environmental, and economic value. So, indeed, we want to have an active role in enriching the discussion sharing our long-term view and commitment, with the aim of stimulating and galvanizing other companies, entities and all the other actors to take a strong action as we did.

Hitachi is a real engine for innovation: can you tell us about some of your technologies that are fostering sustainability? Which solutions are you developing that will allow nations, companies, societies, and people to mitigate the effects of climate change, achieving carbon neutrality?

Hitachi Europe's focus is to ensure that our R&D efforts help achieve a more sustainable future, covering innovative solutions for sustainable infrastructure, smart cities and zero carbon emission mobility solutions.

In the UK, in collaboration with Hitachi Vantara, Hitachi Europe is delivering the 'Optimise Prime'

research project. Optimise Prime is the world's largest commercial electric vehicle trial to date. Hitachi is collaborating with Royal Mail, Uber, UK Power Networks, Centrica and Scottish and Southern Electricity Networks in a three-year trial that will advise and inform the UK Government on how best to develop its EV infrastructure. Leveraging IoT, the charging activity of up to 3000 commercial vehicles is tracked and used to optimise the charging of depot-based vehicles whilst minimizing the impact on the electricity grid.
In addition, Hitachi Europe is aggregating best of breed capabilities and providing financial and digital solutions to enable bus fleet operators and public transport authorities to transition at scale to zero emission vehicles.

In the fight against global warming, we often mention targets, but we speak less about how to achieve such goals, how to get there. Which actions are yet to be taken to speed up this transition to a more sustainable world?
Targets are important, but the plans to achieve such targets are even more important. When we talk with our stakeholders, ESG's agencies and investors, they always want to look at the plan. In order to attain carbon neutrality at Hitachi, we aim at robust energy saving measures: we invest in factories and offices, with upgrades to high efficiency equipment or introduction of renewables sources of energy; we also optimize the use of IoT through the use of our new platform, Lumada, for a smarter and more innovative energy management.
All of these measures are implemented thanks to the highly experienced manufacturing team that we have in the company. We also want to achieve carbon neutrality with direct purchases of renewable energy and other energy sources that do not emit CO_2. We have a strong procurement team on a global basis, this team is already negotiating global deals to switch to renewables energy at Group level. We are fully utilizing Hitachi's buying power, starting from Europe. We will also reduce CO_2 throughout our value chain, by promoting CO_2 reduction on the supplier side, and by expanding the decarbonisation business – for example, offering energy-saving solutions.
In addition to that, since April 2021, our executive pay is linked to the environmental performance as well as the financial performance.

You are a vast, well-diversified corporation that interacts on a daily basis with a vast array of stakeholders: how do you communicate, transfer and pass on the values of sustainability you believe in to your partners?
It's very simple, in Hitachi we call it co-creation. By bringing stakeholders directly into the innovation process, from customers to suppliers, and even competitors, academic institutions, NGOs and government agencies, we have found a unique way to develop innovative, sustainable new products and services in an increasingly complex world.
In fact, this co-creation is a dynamic way not only to successfully navigate the new business conditions, but also to solve society's biggest challenges and support the entire ecosystem of players involved to achieve a sustainable growth. Operating at the intersection of business, government, and society, I believe Hitachi is a true leader in co-creation.
I'll give you an example of why we believe co-creation is the best means of transferring practically the concept of sustainability: a key challenge for the energy sector today is moving to a sustainable low-carbon generation model, and many new products and services need to be designed to help utilities and governments achieve their carbon reduction ambitions. The scope of such projects can be huge, encompassing not only the design and implementation of new, low-carbon generation capacity, but also spreading to the design of large buildings that have power-saving technologies baked in from the design phase, and IT systems that help gauge demand. Co-creation is perfectly suited for such complex objectives and helps to align different players in a single project towards the sustainability of the territory and society. Another case, this time an Italian one, regards the battery-powered tram Hitachi recently tested in Florence. This battery-powered tram offers an opportunity to run high-capacity public transport through city centers while reducing the visual impact on historic streets, saving millions on installing overhead wires. This is perhaps of most use in the Tuscan capital. As Hitachi, we are proud to say that this new technology will allow us to work together with our customers to reduce infrastructure costs while still offering environmentally friendly public transport solutions and we strongly hope this successful trial in Italy creates new opportunities for us across the world.

4. RACE TO ZERO: AN ACCELERATOR OF GROWTH OPPORTUNITIES

4.1. The Italian challenge: guidelines for decarbonisation

At the beginning of last year – and perhaps as early as the end of 2019 – the SARS-CoV2 virus began to spread in China and other countries. Italy was the first European country to be severely affected by it. The strategy to contain the spread of the virus adopted by the Italian Government and followed by almost all other European countries has entailed personal, social and economic sacrifices to protect public health and to avoid the even worse damage that an uncontrolled spread of the virus could have caused and could still cause.

In these hard times, Italy understood before others that Europe had to play a key role in this struggle, and that this time it could and should give a strong, united response. The extraordinary financial plan approved last July by the European Council is also the result of Italy's efforts, and it will provide resources worth €750 billion, of which €380 billion consists of grants. Italy will be the first beneficiary of the plan, with approximately €224 billion in loans and subsidies (at 2018 values).

The very name of the European extraordinary plan – Next Generation EU – shows what the perspective should be. In the words of the President of the European Commission, Ursula von der Leyen, "We choose to not only repair and recover for the here and now, but to shape a better way of living for the world of tomorrow".

The huge resources allocated to build a European Union for the next generations are an opportunity and – at the same time – a great responsibility. For Italy, it is not only about recovering the losses due to the pandemic crisis; it is about moving on from the past and not returning to the status quo before this crisis. Thus, the Recovery and Resilience Plan (RRP) will serve as the cornerstone of this project in conjunction with the other economic planning tools available[1]. It will consent for Italy to continue along the path laid out by Italy's Integrated National Energy and Climate Plan (PNIEC) and the ambitious objectives of the European Green Deal and the 2030 Agenda.

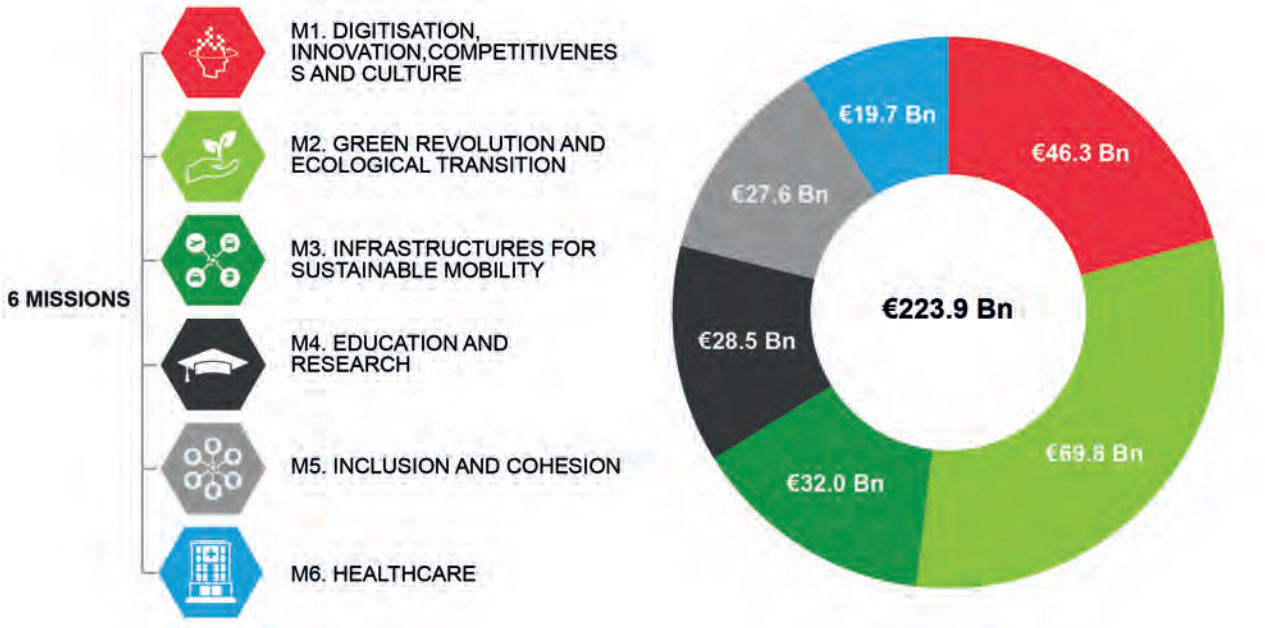
Also, through the RRP's reforms and investments, Italy will accelerate the achievement of the 17 Sustainable Development Goals (SDGs) endorsed by the UN 2030 Agenda. Since 2018, Italy has turned Equitable and Sustainable Well-Being (ESW) indicators into a strategic tool for economic and financial planning. The experience gained in recent years will make it possible to assess whether the results expected from the Plan's numerous lines of action can contribute to the achievement of the individual SDGs and the improvement of ESW indicators.

Articulated in 6 main missions, the Italian RRP makes it possible to deal with the radical nature of the transformations imposed by the dual ecological and digital transition, a challenge that requires strong collaboration between public and private sectors. With the Plan, Italy becomes a key player of the European Green Deal, in keeping with the aims laid out by President Ursula Von der Leyen in her Speech on the State of the Union: to reduce pollutant emissions; increase jobs in the green economy; improve the energy efficiency of buildings; unleash and support the industrial processes of the green transition. At the same time, the challenge of sustainability and emission reduction, in transport and in the production of goods and services, will also be won thanks to digital solutions.

The ecological transition (mainly comprehended in Mission 2 and 3) will be the basis of the new

1 E.g., the European funds available within the Multiannual Financial Framework.

Allocation of RRP Resources by Mission



Source: Italian Recovery & Resiliency Plan.

economic and social development model on a global scale. To to start this process, emissions of climate-altering gases will need to be drastically reduced, in line with the objectives laid down by the Paris Agreement and the European Green Deal. Firstly, it is necessary to enlarge the share of energy produced from renewable sources and to develop an industrial sector in this area, including that of hydrogen. A significant contribution will come from offshore wind and photovoltaic parks. In the primary steel industry, hydrogen is a prospective alternative to natural gas for the production of Direct Reduced Iron (DRI).

Secondly, it is necessary to improve energy efficiency and the use of raw materials in production chains, civil and public buildings and the quality of the air in both urban centres and inland and sea waters. Interventions for preventing and combating hydro geographic instability as well as effective and integrated management of the waste cycle will constitute, together with sustainable management of the agricultural and forestry heritage, a powerful means by which the green transition can improve the quality and safety of large regional and urban areas of the country.

Finally, a specific line of action is necessary to develop sustainable mobility through the enhancement of the infrastructure for rapid mass transport. These include metro, trams, trolleybuses, Bus Rapid Transit and the cycle routes in urban, metropolitan, regional and national areas. There has been an impressive renovation of the fleet of vehicles for local public transport including vehicles with low or no environmental impact and there have been major works to complete the country's electric railway connections.

In conclusion, the Italian Government is fully committed to the RRP and its many lines of action.

The success of the plan will require a contribution from all. Local Authorities and Regions will be a key player in the definition and implementation of the lines of action, and business partners will be called upon to actively participate by bringing innovative and sustainable technological content to enable this profound transformation in the country.

4.2. The role of Hitachi: a leading technology partner for Italy's carbon-neutral future

As said, businesses must deliver the innovations necessary to close the significant gaps in key carbon-intensive sectors and fully enable the green transition. Without a commitment to both sides of the equation, effective climate-mitigation pilot pro-

jects cannot deploy at scale. Translating these ambitious climate targets into action in Italy will require collaboration between government and industry.
By co-creating with leaders in the private and public sectors, Hitachi can help bridge these gaps with novel climate change solutions that digitalize infrastructure, harness the power of data and create synergies across sectors leveraging technologies such as the Internet of Things (IoT), blockchain, artificial intelligence (AI) and big data. As a social innovation leader with deep expertise in operational technology, information technology and IoT, Hitachi is aiming to become a climate change innovator – bringing together its green technology and digital capacity to support cities, governments and companies cut carbon emissions.
Hitachi truly believes, and really intends to be the right partner to realize the ambitious investments of the Italian Recovery and Resiliency Plan, bridging infrastructure gaps with innovative solutions in areas such as rail, electric vehicles (EVs) and the power grid.

4.2.1. Energy transition: Hitachi ABB Power Grids' pivotal role

Access to reliable, affordable and sustainable energy for all is crucial for societies to prosper and progress. Energy consumption is unevenly distributed around the world – a relatively small share of the worlds population and area consumes a large share of the world energy resources. Furthermore, according to the International Energy Agency, today's global energy system predominantly relies on fossil fuels (approximately 80%). This results in greenhouse gas and air pollutant emissions – with drawbacks in terms of climate change and negative consequences on the life of biological systems (plants, animals and humans).
Combating climate change and accelerating the energy transition is of paramount importance and is one of the most urgent challenges of our times. According to the IEA's 'Net Zero by 2050' report (May 2021), 'the path to net zero emissions is narrow' and staying on it requires increased investment in infrastructure, and specifically, an 'immediate and massive deployment of all available clean and efficient energy technologies.' By 2030, the world economy is expected to be some 40% larger but consuming 7% less energy to be on track for net zero in 2050. By this time 'the energy sector will be dominated by renewables' and 'electricity will account for almost 50% of the total global energy consumption' – up about 20% from today. An equitable and sustainable energy transition is at the center of this global challenge, where electricity will be the backbone of the entire energy system.
In a relatively prudent scenario developed by the Politecnico di Torino/Massachusetts Institute of Technology /Enel Foundation study, electrification in Italy (i.e., the electricity share in total final consumption) will reach 46% of final energy uses by 2050, coupled with an 85% penetration of renewable sources in the electricity generation mix.
Benefits can arise from the further electrification of the Italian energy system on energy, economic, environmental, and social aspects. Indeed, the strong reduction of total final energy consumption (more than 40%), enabled by the higher efficiency of the electric technologies, enables the reduction of almost 2/3 the CO_2 emissions by 2050. Italian economy can benefit from this electrification, which can help in reducing 70% of the energy intensity. In parallel, from a social standpoint, electrification can unlock relevant savings in the healthcare (almost €800 billion cumulated savings by 2050) and can boost the energy affordability for Italian families, as the share of income that a family will need to devote to energy expenditures will decrease by up to 17% in 2050.
Electricity generated from renewable energy sources (RES) i.e., wind and solar power, is rapidly growing and where direct electrification is either not efficient or not possible, introducing complementary and sustainable energy carriers, such as green hydrogen. Electricity can be directly generated from renewable energy sources and transferred over long distances while controlled with high efficiency.
The need to integrate large-scale renewable resources into the power grid adds layers of complexity to energy acquisition and distribution models. A fossil fuel-based system taps large, centralized and predictable stores of resources, then allocates them based on consistent and predictable usage. With renewable resources, energy supplies are drawn from increasingly decentralized, disparate and distributed resources that fluctuate in their ability to fulfill demand. As more renewable resources are adopted, the process will become more complex and variable, with availability of renewable energy sources potentially inconsistent and difficult to predict. Therefore, the implementation of an electricity-based energy transition is

strictly intertwined with the extensive deployment of digital technologies to assure reliability, economic and operational energy efficiency.

Utility providers are chartered with ensuring that there is always enough supply to meet demand. In this highly dynamic environment, reliability, efficiency and sustainability depend on sophisticated data analytics and support systems capable of managing energy input and output.

Digitalisation can lead to positive impacts from the point of view of an easier management of the energy systems and of their optimisation. The "internet-of-things" (IoT) will make it possible to connect the physical world (people, machines, materials, buildings, environment, etc.) to the information world (e.g., big data analytics), thus allowing us to process data, providing analyses and foresights.

Hitachi ABB Power Grids brings deep expertise in both information technology (IT) and operations technology (OT), and is already helping companies meet the challenges of developing and scaling flexible, resilient, secure, safe and sustainable energy systems. Through a platforms approach that pulls data from assets to identify their current performance, life expectancy, and risk of failure, the business is providing customers with real-time information helping them to make better informed and proactive decisions. This leads to greater reliability, reduced costs, and increased life cycle value of their assets and the energy system as a whole. But what groundbreaking technologies offer to drive the next big revolution in managing energy – the full adoption of electrification across the world's industries – and enable a greater integration of renewables?

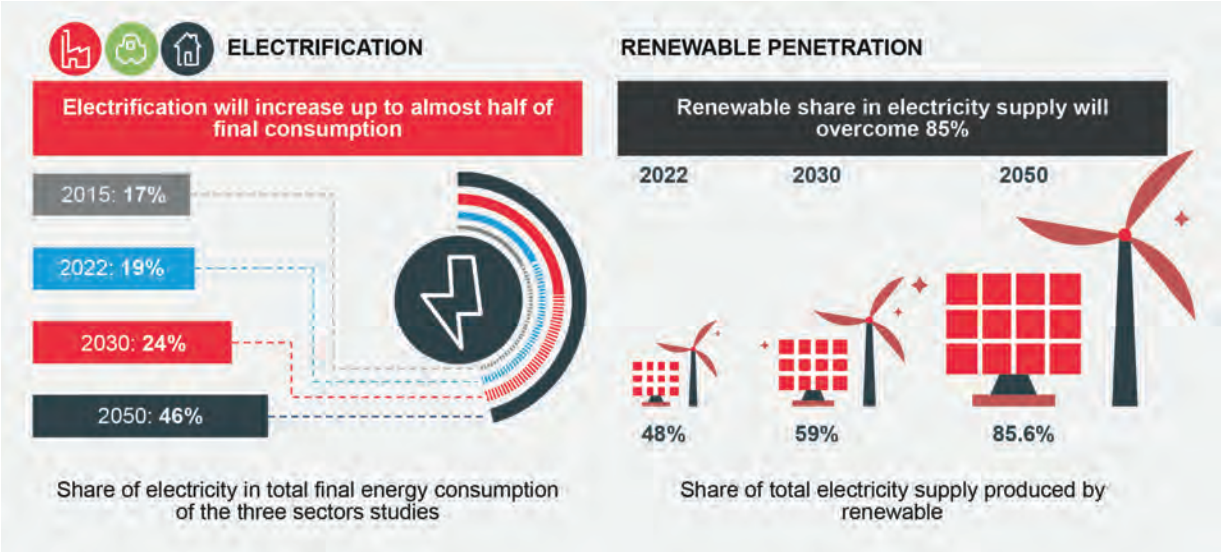
HVDC (High-Voltage Direct Current)

HVDC technology has been recognized as a key technology for enabling the clean energy transition, contributing to the UN's Sustainable Development Goal 7: increasing access to affordable, reliable, sustainable and modern energy for all.

First pioneered by Hitachi ABB Power Grids seven decades ago, commercial HVDC technology can transmit large amounts of electricity over long distances, enabling the large-scale integration of remote renewable energy generation and opening up for new sustainable transmission solutions. Hitachi ABB Power Grids has delivered more than half of the world's HVDC projects.

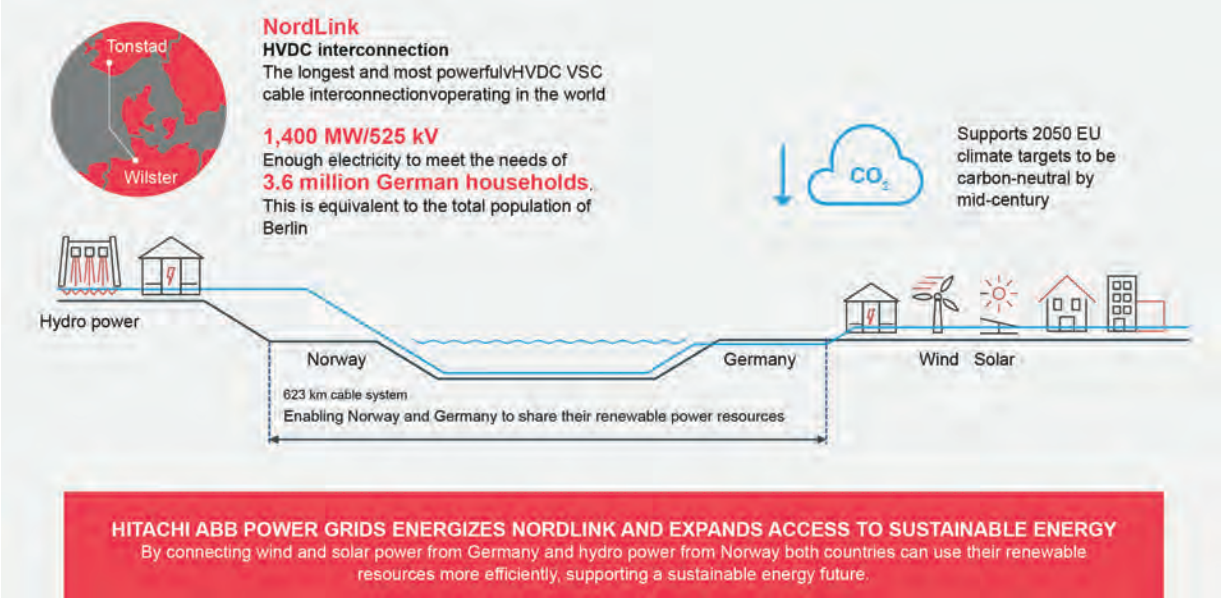
In May 2021, Hitachi ABB Power Grids inaugurated the NordLink project, a 623-km long HVDC electricity interconnection that for the first time links German and Norwegian power markets. With 516 km submarine cable, and 1.4 GW of capacity, the NordLink is the world's first HVDC Light bi-pole installation, expected to supply around 3.6 million German households with climate-neutral energy

The Electrification of the Italian economy



Source: Electrify Italy – PoliTo/MIT/Enel Foundation study.

Hitachi ABB Power Grids energizes NordLink and accelerates Europe towards a carbon-neutral energy system



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by nearly doubling the power transmission capacity compared with earlier systems and improving overall reliability and availability in the grid.

Hitachi ABB Power Grids designed, engineered and supplied the two converter stations – located in Southern Norway and Northern Germany – at the heart of the NordLink project. The connection provides the German power grid reliable access to hydropower resources in Norway, and Norway access to Germany's substantial base of renewable energy, particularly wind and solar energy resources.

Also this year, the business announced that it has won another major order from Dogger Bank Wind Farm to connect the third transmission link, more than 130-km long, from the world's largest offshore wind farm to the UK mainland. The Dogger Bank Wind Farm in the North Sea will have a combined installed generation capacity of 3.6 GW, enough to power 6 million homes in the UK.

Currently the longest and most powerful such interconnection in Europe, these projects make use of HVDC Light technology to expand the stable,

large-scale integration and exchange of renewable power in Europe. This technology marks a major milestone in Europe's goal of linking national transmission grids to create an efficient and integrated energy market and will improve the capacity for cross-border electricity trading.

Other European projects include North Sea offshore wind grid connection projects such as DolWin 1 and 2, and the world's first offshore wind farm, BorWin1. In addition, Hitachi ABB Power Grids is playing a central role in connecting the SSEN Transmission-owned Shetland link to its Caithness-Moray HVDC system for integration to the UK mainland transmission network.

HVDC Light® is the name of Hitachi ABB Power Grids technology that is based on Voltage Sourced Converter (VSC) technology. It is a highly dynamic and efficient alternative to alternating current for transmitting large amounts of electricity with higher efficiency, over longer distances, and with lower electrical losses. HVDC Light® contributes to the secure and stable transmission of power across networks that operate on different voltages and frequencies. This makes the technology suitable for the integration of renewable energy, such as offshore wind farms and interconnecting and strengthening AC networks. This advanced technology also has black-start capability, which enables fast grid restoration in the event of a power out-age.

Floating offshore wind solutions

Floating offshore wind is the next big frontier in offshore wind power. Installed capacity of floating offshore wind installations is forecast to grow as more and more countries in Europe, Asia and North America seek to harness the rich potential of deep-water wind resources. In Italy, Hitachi ABB Power Grids can support the installation of 5 GW of floating wind by 2040, according to ANEV National Association of Wind Energy.

In June 2021, the business launched a portfolio of transformers for offshore floating applications, designed to overcome the challenging offshore environment and withstand the physically demanding conditions on floating structures. The portfolio enables much greater volumes of wind to be efficiently harvested and integrated into the global energy system, directly supporting the transition to a sustainable energy future.

In particular, building offshore presents many challenges beyond the harsh saltwater environment. So far, only a small fraction of offshore potential has been exploited, as in many areas the seabed is not suitable and depths of over 60 meters are not feasible for fixed structures.

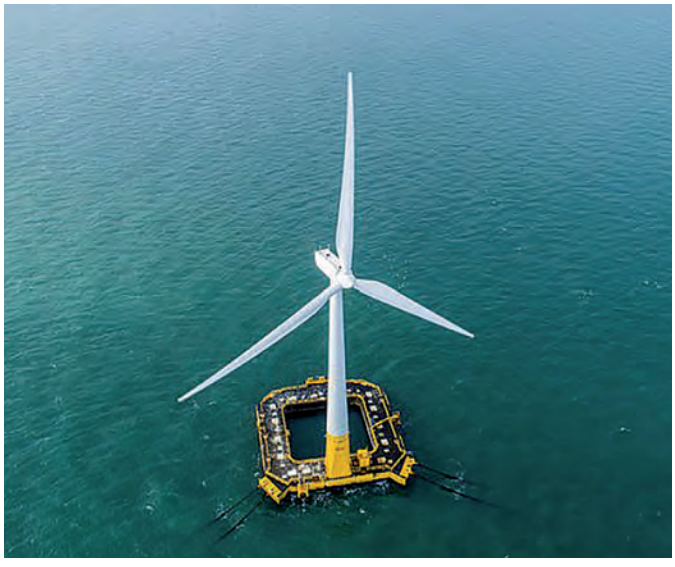
Floating substations and floating wind turbines offer a solution, which can be used in deeper waters, vastly increasing the available global capacity for developing offshore wind energy. Yet floating systems come with their own challenges: over their entire lifetime they are constantly in motion and can be exposed to vibrations and shocks from waves up to 15 meters in height.

This new portfolio introduces a range of collector step-up transformers, earthing transformers and shunt reactors for floating substations as well as wind turbine transformers for floating wind turbines.

Transformers and shunt reactors are key pieces of equipment in the grid infrastructure, enabling transmission of electricity that has been generated by offshore windfarms. This complete and qualified equipment range, developed in partnership with leading floating offshore developers, meets challenging operating requirements with a lightweight and modular design made up of specially designed active parts, tank, tap changer, accessories and external components.

Hitachi ABB Power Grids is pioneering innovative solutions that overcome harsh offshore conditions and have signed a memorandum of understanding with BW Ideol, a global leader pioneer in floating

Example of floating offshore wind technology



offshore wind. This is another mark of the commitment the company is taking to ensure the acceleration of delivering a market-ready floating substation offering and solution to support the offshore energy towards a carbon-neutral future. The business will provide modular, scalable, compact substation packages for installation on BW Ideol's shallow-draft floating platforms. Both companies have worked closely together for several years to co-create a standardized yet modular solution that addresses both market requirements, and the unique demands of operating in the most challenging environmental and seabed conditions. The substations will comprise transformers, switchgear and other high-voltage products specially developed by Hitachi ABB Power Grids for floating offshore platforms.

These game-changing innovative solutions reinforce the business' commitment to supporting the offshore energy towards a carbon-neutral future, enabling much greater volumes of wind to be efficiently harvested and integrated (with stability) into the global energy system, directly supporting the transition to a sustainable energy future.

Green Data Centers

Digital Infrastructures already accounts for 2-4% of global greenhouse gas emissions (Freitag, et al. 2020).

In just a few years the IT industry could cause more carbon emissions worldwide than all motorized traffic. Those emissions, in the context of Data Center infrastructures, are a function of four variables: Data Centre Power Usage, Server and Storage systems utilization, carbon emissions intensity of the electricity grid Data Centers are connected to, and the overall efficiency of the IT environment.

Today modern companies run on data with Data Centres housing the thousands of storage and servers systems that power applications, provide information and automate a range of processes. The number of Data Centres worldwide has grown from 500,000 in 2012 to more than 8 million today (McNerney,2019), meaning they have the fastest-growing carbon footprint of any area within the IT sector. For this reason, energy consumption from Data Centres are attracting more attention, but rather than seeing them as a threat to the sustainable energy transition, and the climate goals outlined in the Paris Agreement, Data Centres may actually present an opportunity to accelerate the transition. Accelerating the transition to low-carbon digital infrastructures is not just an environmental imperative, but also a business opportunity. Companies that are able to capitalize on the market opportunities of a low-carbon economy will have a foot forward in any market, avoiding the risks of potential increased operational and capital costs due to potential carbon taxes and investment in carbon-emissions mitigation measures which may lead to lower profitability.

Globally, Data Centres accounted for approximately 1% (or 205 TWh) of global electricity use in 2018 (Masanet et al., 2020; Pearce, Fred, 2018) and estimates suggest that annual electricity demand could grow to as much as 8,000 TWh by 2030 in the worst case scenario and to as low as 1,100 TWh under the best-case scenario (Nature, 2018). However, despite concerns raised surrounding the growth of data centres (and the electricity required to power and cool them), a new study found that while their computing output jumped sixfold from 2010 to 2018, their energy consumption rose by only 6% (Masanet et al, 2020).

Adopting more efficient IT architectures will prove crucial for saving energy consumption. First of all, the flattening of the increasing carbon emissions trajectory can be realized through capacity virtualization. Virtualization is one of the "high-level best practices" alongside more obvious measures such as turning off unused equipment and decommissioning unused servers. This significantly increases the utilization of physical servers (best practice is 70%) by enabling multiple applications to run on one server and slowing down servers growth.

In addition, considering that all organizations continue to generate and handle increasing amounts of data that is critical to their business, they would benefit from the elimination of useless data volumes. An 80% energy saving in power and cooling can be achieved by data storage systems consolidation (Masanet et al. 2015). Also, the right disk drive technology can make a big difference: at least 80% reduction in power use of Serial Attached SCSI -SAS to Solid State Drive -SSD (Austrian Energy Agency, 2011). The use of intelligent management software with the AI supervision to optimize storage methods of useful data as where and how long data to be stored can increase the efficiencies. Finally, highly efficient infrastructure supervised by AI can optimize multiple dimensions of energy consumption, relating to the infrastructure itself.

AI can analyse data output, humidity, temperature, and other important statistics in order to find a way to improve efficiency, drive down costs, and reduce total power consumption.

The shift to cloud computing which relies on hyperscale data centers – the largest and most efficient type of data centre usually run by the Big Tech companies – has further accelerated efficiency improvements, as they boast cutting-edge technology (facility designs, cooling systems, and workload-optimised equipment) in order to reduce (energy) costs. In fact, on average hyperscalers only require 16% of the power compared to on-premises infrastructure.

A great contribution to these results is due to Kubernetes, a containerization technology. The introduction of Kubernetes into cloud environments helps to run the same workloads with only 1/10th of the Virtual Machines (Patrick Kirchhoff,2020). Higher utilization means less resource wastage, fewer machines, reduced infrastructure footprint and less power required to run it. This, in turn, leads to a reduction in the carbon emissions associated with operating infrastructure. Via application containerization it is possible to save up to 50% of server capacity by eradicating Operating Systems (Kreten et al, 2018).

Because of this, moving on-premises workloads to large-scale data centres can lower the workload carbon footprint by 88%.

Also, the rapid deployment of renewable power generation bodes well for data centres, as electricity accounts for as much as 70% of their total operating costs. As the demand for cloud computing services has increased, the share of renewables powering these data centers has increased. Electricity systems themselves have become more complex over the past few decades with increased decentralisation, decarbonisation and digitalisation, leading to increased reliance on data analysis. In effect, renewables are contributing to the increased demand for data centres, whilst simultaneously helping to decarbonise them.

Data centres sit at the nexus of energy efficiency, renewable energy, and burgeoning data economy enabled by digitalisation. By integrating the latest technologies and leveraging the renewables and the increased efficiencies made possible by high density storage systems, virtualization, containers and artificial intelligence, data centres can help accelerate the green transition.

Given their vast energy usage and their highly automated and "intelligent" nature (due to the integration of IoT devices and machine learning algorithms to optimise power usage), data centres solutions represent one of Hitachi's core business areas. By combining the IT, OT and Energy souls, we can provide cloud-based infrastructure for ingesting, visualising, analysing, and securely storing IoT data collected digitally from machines, devices, and sensors. This allows us to assist customers harnessing IoT data. Hitachi can leverage more than 60 years of experience to design, implement, and manage IT Infrastructures, protecting them from security vulnerabilities, and manufacture sustainable solutions providing industrial power and automation, from transformers and smart substation automation to modular sustainable substation designs.

Looking at the energy sustainable transition as a whole, Hitachi can be the logical partner of choice to support the realisation of some ambitious projects included in the Italian RRP: from ensuring grid resilience, to contributing to the installation of new renewable capacity from offshore plants in Canale di Sicilia and Adriatico sea, and major HVDC projects, to building green data centres for the Italian Public Administration.

Hitachi's Data Center

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Interview to Claudio Facchin, CEO Hitachi ABB Power Grids, July 2021

Could you introduce us to Hitachi ABB Power Grids and its core 'purpose'?

Hitachi ABB Power Grids was created as a joint venture between Hitachi and ABB in July 2020 and will be christened as Hitachi Energy from October 2021. We are a global technology leader with a combined heritage of around 250 years, employing more than 36,000 people in 90 countries. Headquartered in Switzerland, we serve utility, industry and infrastructure customers across the value chain, and also provide solutions for emerging areas like sustainable mobility, smart cities, energy storage and data centers.

With a proven track record, global footprint and an unparalleled installed base, we aim to balance social, environmental and economic values. And when it comes to our core 'Purpose', we are committed to ***Powering good for a sustainable energy future****, with pioneering and digital technologies, as the partner of choice for enabling a stronger, smarter and greener energy system.*

How do you align your sustainability approach with the United Nations Sustainable Development Goals?

To start with, I would like to acknowledge our parent companies Hitachi and ABB for their rich legacy in this area. At Hitachi, sustainability is woven into the fabric of our business and closely related to the UN SDGs with a vision for the future based on a human-centric society that provides for a better quality of life for all while maintaining harmony with nature".

In keeping with these goals, we recently articulated Hitachi ABB Power Grids' strategic ***Sustainability 2030*** strategy, summarizing our main commitments to act and drive business in a sustainable way. It reaffirms our 'purpose' and promise to contribute to a sustainable energy future. With electricity as the backbone of a clean energy system we remain focused on 'walking the talk' and supporting our customers with technologies for sustainable solutions.

Our sustainability approach reiterates our commitment to the UN Sustainable Development Goals (SDGs), through 11 Targets aligned to 8 UN SDGs.

We are guided by 4 pillars: Planet, People, Peace and Partnerships.

- **Planet**: we aim for carbon-neutrality in own operations and target to reduce our emissions along the value chain by 50% with customers, partners, and suppliers.
- **People**: we believe diversity and collaboration translates into great innovation.
- **Peace**: everything we do is based on safety, integrity and quality – our licenses to operate – that help us promote peaceful and inclusive societies for sustainable development.
- **Partnerships**: with customers & partners, co-creating solutions to foster carbon neutrality

Each pillar has corresponding targets that drive our business to contribute social, environmental and economic value, ensuring a holistic approach and powering our purpose.

How you work with customers and other stakeholders in furthering the vision of carbon neutrality?

Environment is front and center for us when it comes to our 'purpose': *Powering good for a sustainable energy future*, and we engage all our stakeholders in driving this cause.

We start with **ourselves** by walking the talk and ensuring comprehensive management and employee engagement with sustainability at the heart of our purpose.

We collaborate closely with **customers and partners**: to accelerate the energy transition, building on our rich technology and innovation heritage and leadership, to deliver eco-efficient solutions across the world. An outstanding example of this is HVDC – a technology we pioneered and where we are market leaders. HVDC will be key in facilitating the energy transition through applications like offshore wind integration and interconnections that require long distance transmission of large amounts of power such as remote renewables across long distances (overhead, underground or under water) with minimum losses and optimum footprint.

The NordLink interconnector linking Norway and Germany, enabling exchange of clean energy sources like wind, solar & hydro power ; the integration of the world's largest offshore wind farm Dogger Bank (A,B,C) and the 6,000-megawatt (MW) 1800 km ultra-high voltage Raigarh-Pugalur link in India are some recent examples of HVDC deployment.

Alongside solutions for bulk power, we also provide grid-edge and distributed power technologies including microgrids, storage and software-based solutions to integrate renewables and mitigate fossil fuel impact.

In addition to customers and partners, we collaborate with **governments** to help shape the policy and regulatory landscape, with **institutions**, with **Academia** and the **communities** we serve. In fact, in our quest for sustainable energy we even work with **competitors** if required (e.g., recent agreement on SF_6-free high voltage switchgear solutions as part of our eco-efficient EconiQ portfolio).

What are the key enablers that can help us to accelerate the energy transition and turn vision into action, as urgency to address climate change increases?

The energy sector is central to address the climate change challenge & achieve our Carbon Neutrality vision and *Electricity will continue to be the backbone of a clean energy transition*. Electricity demand has consistently grown at nearly twice the pace of overall energy demand and is set to continue. To accelerate sustainable energy development and achieve our decarbonization goals, we must act with a sense of purpose and urgency.

Some *key enablers and catalysts* that can make a difference are:

- We must ADAPT and ADOPT policies & regulations that enable the deployment of technology & facilitate new business models to support Secure (Strong), Sustainable (Green) & Scalable (Smart) energy infrastructure such as power grids.
- Deployment of technologies and rapid digitalization.
- Collaboration across stakeholders (e.g., policy makers, regulators, utilities, technology providers, consumers) and across sectors and geographies can be a major catalyst.

We must strive for a 'just and inclusive transition' and a holistic model that addresses social, environmental and economic priorities.

How is Italy placed with regards to the energy transition and what do you see as the key opportunities and priorities from a power sector perspective?

The Italian government has defined three focus pillars: modernization, inclusivity and a robust energy transition. It also issued an integrated National Energy and Climate Plan 2021-2030 signaling a shift towards decarbonization in Italy's energy and environmental policy. Its main objectives included:

- Reduction of greenhouse gas emissions by 40% (from 1990 levels);
- 30% increase in share of renewable sources in gross end energy consumption, which translates to 55% of the electrical demand met by renewable generation;
- Improved energy efficiency by 43%.

In April 2021, Prime Minister Mario Draghi, presented a €248bn National Recovery and Resilience Plan (PNRR) and submitted a reform program to the European Commission as part of the Next Generation EU, a €750bn recovery instrument (2021-2027) aimed at addressing the economic crisis caused by COVID-19.

Italy is expected to be the biggest beneficiary from the EU's ~€750bn COVID-19 recovery plan expecting to get ~€200bn which includes the money it would receive under normal circumstances through the 2021-2027 EU budget and an additional €81.8bn from the additional recovery fund. Recently, the EU also proposed its *Fit for 55* package aimed at curbing greenhouse gas emissions by at least 55% by 2030 based on 1990 levels (compared to previous objective of 40% reduction as per Paris Agreement). Italy is aligned with the same objective.

As another example highlighting Italy's commitment to accelerating the energy transition, Terna announced it will invest 18.1 billion euros ($21 billion) in the Italian power grid over the next 10 years to meet energy transition demands and boost economic recovery. It stated that projects in the new long-term development plan for the national grid would make it possible to cut carbon emissions by 5.6 million tons per year, twice that of the previous plan.

In terms of priorities, in addition to ensuring the appropriate funding being allocated to the energy transition, Italy needs to ensure the right policies and regulatory measures are put in place to clear bottlenecks and hurdles. It also needs to deploy technology and digitalization across the value chain from generation through to transmission, distribution and consumption. Above all, collaboration across stakeholders will be a key success factor in facilitating progress.

4.2.2. Sustainable Mobility and Smart cities: green links connecting the country

When thinking about the transition towards a sustainable energy system, the implementation of electricity as a means for energy transition implies the so-called "electricity triangle": power generation from renewables, with electricity as the main energy vector and electrification of final uses in all the sectors (buildings, industry and transport).

Specifically, the transportation sector (aviation, rail, shipping, heavy and light trucking) is responsible for approximately 16% of global greenhouse gas (GHG) emissions and 28.6% of the Italian GHG emissions (99.5 million tons of CO_2 equivalent in 2017).

At present, the greatest emission contribution is given by road transport – mainly cars and buses (93%). 90% of passenger traffic in Italy is on roads (860 billion passenger kilometers per year), whilst only 6% uses the railway. It's how we move between home, work and leisure that makes much of the difference: out of 39.5 million vehicles registered in Italy at the end of 2019, electric vehicles account for only 0.1% of the total. 46% of the fleet is petrol powered, 44% diesel powered and 9.9% has an alternative power[2] (ACI – Automobile Club d'Italia).

The national transport sector is hence responsible for significant GHG emissions, with fossil fuels still representing the main source of energy.

Therefore, as the impacts of climate change become increasingly difficult to ignore, the electrification of transportation on a massive scale is necessary to help reduce carbon emissions. Replacing conventional gas and diesel-powered vehicles with electric vehicles (EVs) powered by carbon-free generated resources don't just eliminate a major source of carbon emissions, but also lower costs and increase efficiency for the commercial and public transportation sectors, contributing to achieving a carbon-free society.

Sustainable mobility in this sense is one of the most important frontiers in defining the world of tomorrow, and the Italian NECP and the Long-Term Strategy (LTS) give the transport sector a central role in the decarbonisation path to 2030.

In general, the Italian Recovery and Resilience Plan aims at developing more sustainable local transport, not only for the purpose of decarbonisation but also to improve the overall quality of life (reduction of air and noise pollution, reduction of congestion and integration of new services). Main actions include:

- Significantly upgrading the rail network with the construction of new high-speed railways and the introduction of "green" trains (e.g. purchase of 53 electric trains).
- Investing in "soft" mobility, promoting rapid mass transit, intramodality and the use of bicycles through the construction of a total of 240 km of equipped infrastructure.
- Accelerating the diffusion of "green" local public transport, with a program of major renewal of the obsolete bus fleet towards low/zero emission solutions and installation of related charging infrastructure.
- Developing an adequate public electric charging infrastructure network (with the development of 7,500 recharging points on highways and about 13,750 recharging points in urban centres) for the 6 million electric vehicles expected by 2030.

Railway

In Italy, most railway lines (72%) are already electrified, but some diesel lines remain, mainly at regional level. However, as said, rail represent only 6% of national passenger transport (vs. 7.9% in Europe). One of the main goals of the Italian RRP is to shift about 10% of total demand of road transport by 2026.

In particular, by supporting the shift of passengers and freight traffic from road to trains – powered by electricity or hydrogen – road congestion will be significantly reduced and so will related GHG emissions.

RFI estimates that an increase of the share of passengers using the railway from 6% to 10% could result in an annual CO_2 saving of 2.3 million tons by 2030.

Moreover, investments on the regional rail fleet will improve comfort and reliability of suburban rail connections, which in turn can result in a modal shift from private cars. Today, the train fleet for regional local public transport is composed of 479 trains which present an average age of 29.3 years. The fleet includes 221 diesel trains and 258 electric trains.

Italian investments made recently on local rail

2 The 3.9 million alternative fuel cars reported a 7.9% growth and are broken down as follows: 2.57 million petrol-LPG (6.5% share), 0.97 million (2.4% share), 0.02 million battery electric (+ 0.1%), 0.32 million petrol hybrid (0.8%), 0.02 million diesel hybrid (0.1%), other 0.01 million.

transport have indeed produced positive effects with a growing share of citizens giving up private cars because there was an alternative mode of transport. Hence, a renewed train fleet will be effective in promoting modal shift from private cars thus favoring reduction on traffic congestion and related GHG emissions.

The "Rock" Train, built largely from recyclable materials, is the new high-capacity "green" regional train designed and built by Hitachi for Trenitalia. With three possible configurations with 4, 5 or 6 carriages, it can reach 160 km/h with an acceleration of 1.10 m/sec^2 and accommodate about 1,400 people, with over 700 seats in the longest composition.

The new technology is able to minimize the environmental impact: travelling on the "Rock" train generates only 5.1 grams of carbon dioxide, whereas travelling by car generates 100. The environmental impact, incomparably lower, makes the "Rock" the means of transport with the lowest environmental impact in Italy.

The first vehicle built for Emilia Romagna started operating in May 2019, but it will travel to many other Italian regions such as Veneto, Liguria, Tuscany, Lombardy, Lazio and Campania.

However, track electrification is time consuming, expensive and in some cases difficult to accomplish. To overcome this, Hitachi is developing battery and hybrid trains as an alternative.

Battery power is the cleanest zero-emission solution to replace diesel trains whilst supporting cost efficient and sustainable new train delivery options for non-electrified routes.

This technology allows travel beyond electrified routes, ensuring seamless journeys and an integrated passenger experience that benefits operators and the environment.

Hitachi's trains are "tri-mode" – able to switch seamlessly between diesel power, overhead electric power, or battery power. They can run on battery power alone for 100 km and offer fast charging solutions.

As battery and charging technology develops, their range will only grow, helping cut emissions and pollution in stations, cities and beyond, to reach net-zero emissions faster.

Hitachi has some strong experience here with five years' experience operating the Dencha battery trains in Japan, Hitachi's UK partnership with Hyperdrive (now Turntide) and Eversholt, Florence battery trams and the introduction of new tri-mode regional trains in Italy.

UK Regional Battery Train

Hitachi is working on a number of battery train projects, from the Dencha Japanese train to the UK regional battery train.

The UK battery train can reach top speeds of near of 144-162 km/h, without compromising on seats, carriages or passenger experience.

Travelling up to 90 km just on batteries and recharging whilst in motion under the wires, it offer seamless journeys on non-electrified suburban or branch routes, particularly around key towns and cities.

Battery Hybrid Train

A quick and easy application of battery technology is to install it on existing or future Hitachi intercity trains. A retrofit programme would involve removing diesel engines and replace with batteries.

Hitachi Rail's modular design means this can be done without the need to re-engineer or rebuild the train, this ensures trains can be returned to service as quickly as possible for passengers. Adding a battery reduces fuel costs up to 30% or increase performance.

These trains can enter, alight and leave non-electrified stations in battery mode reducing diesel emissions and minimising noise – helping to improve air quality and make train stations a cleaner environment for passengers.

Hitachi's battery solution complements electrification, connecting gaps and minimising potential infrastructure costs and disruption to service.

Interview to Andy Barr, CEO Hitachi Rail, August 2021

Trains relying on alternative power sources – such as battery trains – will revolutionize the train industry in the years to come, allowing journeys in new, non-electrified routes. Hitachi Rail is at the forefront of such technology. Can you tell us how you are leading the industry into a decarbonized future, and why battery-powered trains are so important in the fight against climate change?

Batteries are of course very important, and I will talk about that shortly. If you look at our overall decarbonization strategy, rail is already a very green mean of transportation, and I believe we can achieve a modal shift by Mobility as a Service, as well as getting people out of their cars and out of planes and onto public transports, by making it a credible alternative. We need to decarbonize rail: batteries are very important because are the fastest way to get there quickly. We also worked on decarbonizing our own business, so we managed to reduce our CO_2 equivalent emissions by 14% per hour in the last year. We plan to get to net zero by 2030. As far as batteries are concerned, we are already innovating, with batteries being fitted onto intercity trains as well as city trains, moving rails away from diesel. These are key steps allowing us to become climate innovators. We already have over five years of experience running battery trains in Japan, and we have a UK partnership with Hyperdrive Innovation manufacturing batteries, along with Eversholt Rails, the owner of some of the trains we built. In Italy we have tested a battery-powered tram in Firenze, and the Blues train, which is pioneering an area that we believe even more critical. Battery is at the forefront of our offering and our products. We believe this could be extremely important over the next few years. Having trains running on electrified lines would be our target, but I think that having trains equipped with batteries are a way to generate growth quickly on those routes to enable us to make a business case to run electrically powered train on routes that previously would have been run with older, diesel-powered train.

What about hydrogen? The use of Hydrogen-powered trains on a mass scale is still some decades away, but there is a lot of excitement and hope surrounding this new mean of propulsion. What is your stance on this technology?

Hydrogen will have a place to play in the long run. Already in Japan we are partnering with Toyota to run the HIbari project that will launch in the next year. It's a very exciting project that we are keen to

exploit, a project that will test the viability of this technology in the long run. If you compare batteries and hydrogen today, hydrogen is not really competing at the moment – batteries have a 20% higher carbon efficiency, and a 30% to 50% lower cost then hydrogen. It is worth remembering that are a number of challenges with Hydrogen, and it is going to take time to make sure we get it right. For instance, only 1% of all the hydrogen manufactured currently uses renewables sources, the remaining is produced using mainly fossil fuels. It also needs to be fast, and we need to scale this up for our projects, with an infrastructure and an ecosystem to support that. This means in particular specialized fueling stations – which are currently expensive and need special measures to manage them at each end of the route. Hydrogen trains have also a 30 to 40 years life: we need also to make sure that we can maximize the opportunity to retrofit diesel trains which are still running. Rolling out the Hydrogen technology in scale will be quite a big long-term challenge that will take us well in to Sixties. By 2060, it could happen that the battery technology has moved on, becoming comparable to hydrogen. One advantage of hydrogen-powered vehicles is that they can be refueled quickly, just as it happens now with fossil fuels. But the battery technology continues to advance, and already offers comparable benefits to the one enjoyed by fossil fuel trains.

Two years ago Hitachi Rail completed the acquisition of 100% of the Italian signaling company Ansaldo STS. How this takeover helped you to diversify and become a full-service provider for railways, becoming a one-stop shop for transport projects?

Becoming a full-service provider is the ultimate goal for our business, in particular when you look at the opportunity to move into the Mobility As A Service space. The acquisition of STS enabled us to diversify our business, bringing in the signaling technology. We now have in our portfolio some of the most innovative railways around the world. We managed to integrate Ansaldo Sts into the wider Hitachi Rail Group: we now have an integrated approach which offers bespoke solutions, from building infrastructures to signaling and control, all of which is designed by our experienced engineers. We have cutting-edge technology in an automated transport system, which are

designed to maximize the whole life cost. Of course, being automated means they can be closely controlled, without the need for additional staff members, in particular the driver. We can also manage the operations much closer to the way the operator would want to be, being responsive to changes in demand. As you can see, we have significant projects in our portfolio, including automated railways in Copenhagen, Riyad, Genova, Taipei, Honolulu and Milan, along with new projects that are coming up in places like Lima. Providing innovative solutions across a wide range of services, through building of the rolling stock, providing the control systems and the building of the networks, integrating that with signaling and control into a full operations and service, means that we have a unique offering in the marketplace, putting us in a strong position to support our customers as we move into new areas with these exciting new technologies.

Hitachi Rail's projects are all over the world, ranging from Tokyo to Copenhagen to Genoa or Riyadh. How do you ensure that the company's values, level of innovation and commitment remains untarnished, regardless of the ground in which you are operating?

We are a very big company. We are present in 38 countries all over the world, with eleven manufacturing sites on three continents. Our 12000 employees already embody the Hitachi's value of harmony, sincerity, and pioneering spirit in everything they do. These values are important because they are expressing the idea of translating our thoughts into action, and this is how we drive our business. Our purpose is to contribute to society through the development of superior, original technology and products that power sustainable connectivity. We take pride in everything that we do, putting our projects at the forefront, with the highest standards we manage to achieve, using these values to work closer with our customers as well to make sure we can continue to be a trusted provider in the future, thanks to heritage that we have from our past.

The pandemic has changed the common perception of train travel. People are now more reluctant to board crammed trains and subways: they demand reduced physical contact, more space, heightened hygienic conditions. How are you facing these changes challenging the transport industry?

The pandemic has taught us several lessons, ranging from strengthening business continuity to increasing the company's resilience to react to unprecedented events. Above all, the pandemic has taught us that is quite difficult to predict future events. Transportation is a fundamental part of every community, every city, every country. We need to make that transportation offers a credible alternative, and the enhancements that we bring, allows stronger connectivity in major cities to get those benefits on a wider level. I think important to that is encouraging people onto rail and away from means of transportations such as cars and scooters, but also away from air travel. This is a very important way to reduce carbon emissions. To make this credible, keeping the cost down, making attractive and helping the operator to optimize the operation is of paramount importance. If we make these things right, people will shift to rail travel, because they will see the attractiveness of it. From a sustainability point of view, public transports on rails play a big role in making the cities less polluted, having the lowest carbon footprint possible. Another major lesson we learned from the pandemic is that we think the people's travel habits will change in the future, they will be different. We need to be ready for that. The demand will still be there, although in a different way: for this reason, making rail transportation clean, attractive, sustainable is an extremely important task.

When you think about the future of overall mobility, what do you envision? Cars have never gone away, despite the rise of alternative means of transportation such as more widespread subway and trains networks, or electric scooters and mopeds...how can we reduce traffic congestions and free up our cities?

We believe the future of mobility will be defined by what we call "sustainable connectivity". Solutions with the lowest carbon footprint and the greatest convenience for the passenger will be really important. As a business we are investing in innovation, so we can provide solutions to meet future megatrends: autonomous vehicles, digitalization, sustainability, and urbanization. Customer experience must be the best possible, to be perceived as a valid alternative to fossil fuel transportation. We are also investing in data capability, so that we can manage people's journey end-to-end, enabling the operators to improve their operational efficiency so that we can preserve the customer experience real-time during journeys. This investment will allow us to have good information about journeys, making them responsive, so we can have the correct levels of trains available, in particular when you have an unusual number of people in one location. Ultimately, we are investing for the future in digital innovation with products on our IoT platform Lumada and working with Global Logic, a company that has recently joined the Hitachi's group, to make sure we can bring this new concept into our own company and maximize the opportunity to make this fit with our ultimate goals, so that we can focus on meeting the future demand in cities for sustainable public transport.

Metro & Tram

The further and decisive impulse towards the direction of sustainable mobility is then given by the metro and tramway systems in the urban mobility. In 2016, Italy registered about 1,000 km of network equipped for rapid mass transport services in the city[3] (Pendolaria, 2016) against 155,000 km of road network (European Road Network, 2020). Private cars share on total passenger trips – including walking – is more than 60%, while public transport is just about 10% (data for 2019, Isfort, 2020). This can lead to traffic congestion, especially in metropolitan areas.

Clearly, measures to strengthen the rapid mass transportation system are fundamental to ensure the modal shift from private cars and promote a true sustainable mobility in urban areas.

Hitachi's autonomous metro represents a world-class product. It is a highly integrated automatic transport system, characterized by a vehicle without driver's cab, capable of ensuring high performance and high levels of comfort and safety. The autonomous technology allows a wide flexibility in railway operations since it can vary the train cadence, adapting them to demand, increasing the availability during peak hours and reducing it at other times. This also leads to a significant reduction in energy consumption throughout the day.

Hitachi is the largest autonomous manufacturer in the world with 30% market share. It started in 2002 with the first metro in Copenhagen, then in Italy. This was followed by Line 5 in Milan, Brescia, Line C of the Rome metro and abroad in Saudi Arabia in Riyadh and in Taiwan in Taipei. Other projects are in progress in Honolulu, Hawaii, Thessaloniki, Greece, and Australia.

Honolulu Rail Transit Project in Hawaii, USA

By using rail transportation to provide the equivalent mobility of 40,000 fossil-fuel vehicles that people would otherwise use to commute to work or school each day, it is estimated that the new Hitachi service will deliver an annual reduction in CO_2 emissions of 210,000 tons. This is equivalent to 12% of Honolulu's total vehicle CO_2 emissions. Trains are expected to enter service in 2021.

3 The city considered are Milan, Rome, Naples, Genoa, Turin and Catania.

Hitachi's autonomous metro in Copenhagen, Denmark

Moreover, Hitachi has developed a new battery tram that can be adapted to existing trams running with traditional catenary systems, allowing them to operate without catenary.

This technology allows trams to travel on some sections of their routes that do not have overhead wires, such as the historic centres of cities. This translates into better environmental performance, less impact in the urban context and cost savings for infrastructure installation.

The new technology is based on an on-board energy storage system (OBESS), flexible and able to be installed on the roof of existing vehicles with the aim of contributing to the creation of a sustainable society and the well-being of people throughout the world, consequently improving their quality of life.

The first test run of the battery-powered tram took place in Florence in early 2021, allowing Hitachi to lead the way in Italy for this new technology.

Hitachi's first battery-powered tram in Florence, Italy

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Mobility as a service (MAAS)

Cities are growing. Today, they account for approximately 55% of the world's population and about 80% of global GDP. These numbers are likely to increase to 70% and 90%, respectively, by 2050. That growth exacerbates all kinds of challenges, with more people on the road (often commuting on their own in a vehicle) and crowded onto trains and buses. The result is gridlock, congestion, pollution, and overall inconvenience.

Mobility stands out as an area of challenge, and opportunity, for cities. It's expensive – the largest or second largest area of capital spending for most cities. It has become a focus of innovation and entrepreneurship, with ride-hailing and micromobility companies operating around the world, autonomous-driving pilots underway, and city-led mobility-as-a-service (MaaS) platforms being pioneered in several urban areas across the world.

As there are new modalities and service providers, transportation systems become more modular and less coordinated, presenting increasing difficulty in achieving the optimal solution in terms of traffic flow, asset volume, and utilization. This creates bottlenecks, a lack of coordinated services and schedules between different modes, and "white spaces" where services aren't available, such as getting to and from a train station.

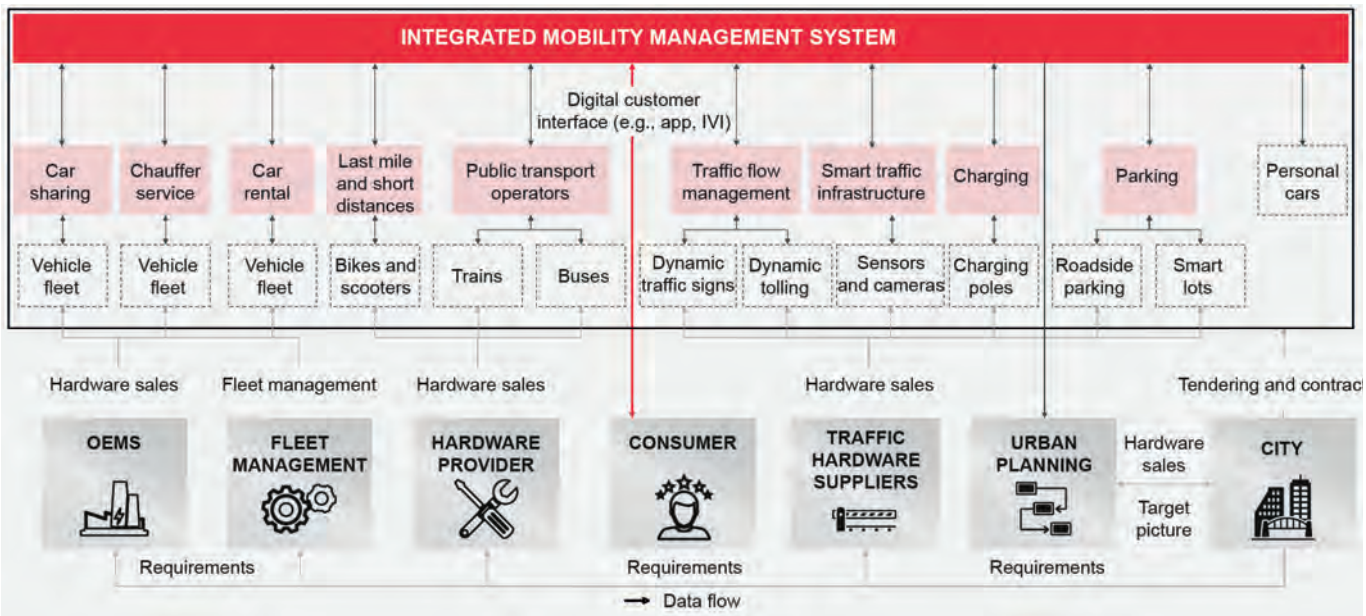
But cities are not just swamped by new offerings and players. A fundamental shift in transport is underway that has big implications for how mobility ecosystems function. As recently as 2017, each player had a clearly defined role: automotive OEMs made their money selling personal vehicles and components, other private companies operated taxis or provided adjacent transport solutions such as bikes and scooters, and city authorities operated mass-transit and traffic management systems.

But that's starting to change. Fast forward to 2035 and we expect to see a shift in profitability from traditional areas such as new car sales, parts, and maintenance to on-demand mobility, data, and connectivity. As part of this transformation, urban mobility solutions will be delivered and consumed as a service via digital devices, accelerating the shift away from personal-vehicle ownership.

To fight chaos, congestion, pollution and improve travel times, convenience and cost, rather than just improving public transit or regulating ride-hailing operators, cities should figure out how to synchronize all commuting options by identifying and addressing pain points and white spaces, so to create more integrated and efficient networks.

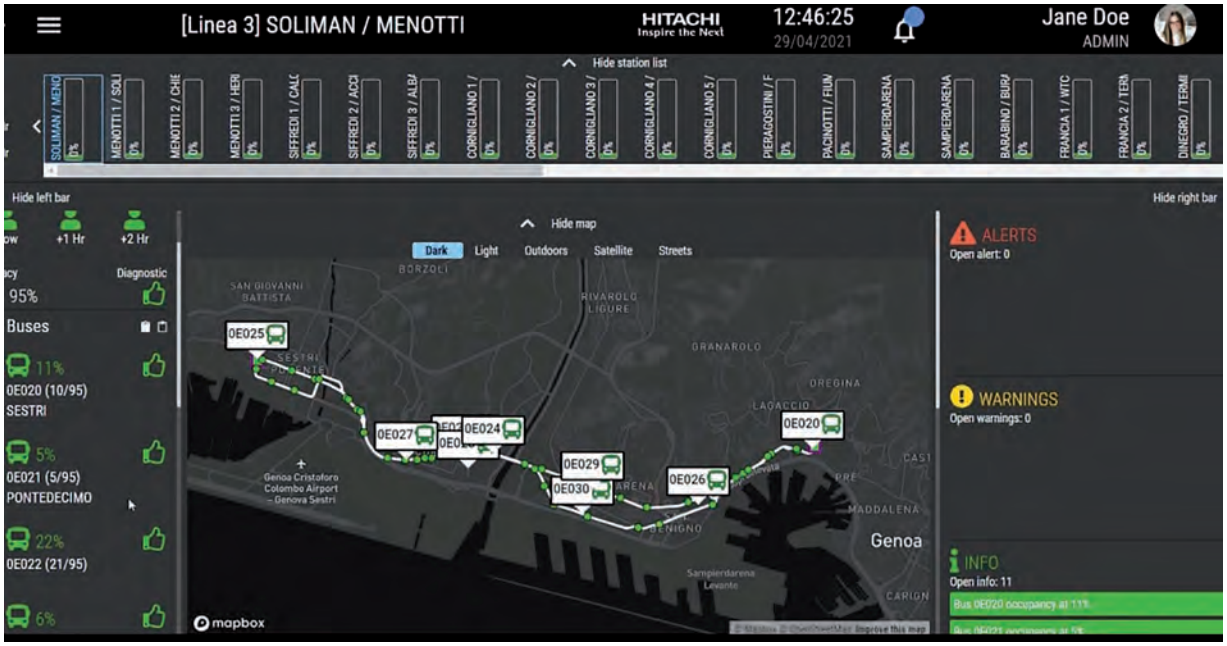
In fact, the lack of systemic direction is a key reason that the influx of new mobility modes into

An integrated Transport System can optimize Urban Mobility



Source: BCG analysis.

Genoa starts trial of Hitachi congestion monitoring system on AMT buses



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cities have increased the complexity but not the overall performance of today's urban transport.

The key to solving the urban mobility challenge is therefore to imagine a city's transport network as an ecosystem that has an orchestrator at its center. Whoever takes the lead in orchestrating urban mobility must ensure that public and private operators in the fragmented mobility ecosystem work together effectively, to enable a resident-centric, end-to-end ecosystem.

The leaders in urban mobility will differ by region. In some areas, the orchestrator may take the form of a public-private partnership, or it could be a city that contracts out orchestrator services to the private sector. Crucially, the orchestrator will own or direct two key elements of the urban transport system:

- An integrated mobility management system that consolidates the data from all public and private travel modes as well as from the city's transport infrastructure (via smart traffic management, parking, and tolling systems).
- A digital customer interface, also called a MaaS platform, that combines all transport options in the city and becomes an end-to-end mobility option with the most efficient journey possible designed on the basis of data from the integrated mobility management system. Through this single interface, commuters can easily plan a trip involving multiple modes, compare options, book transport, and pay for their journey.

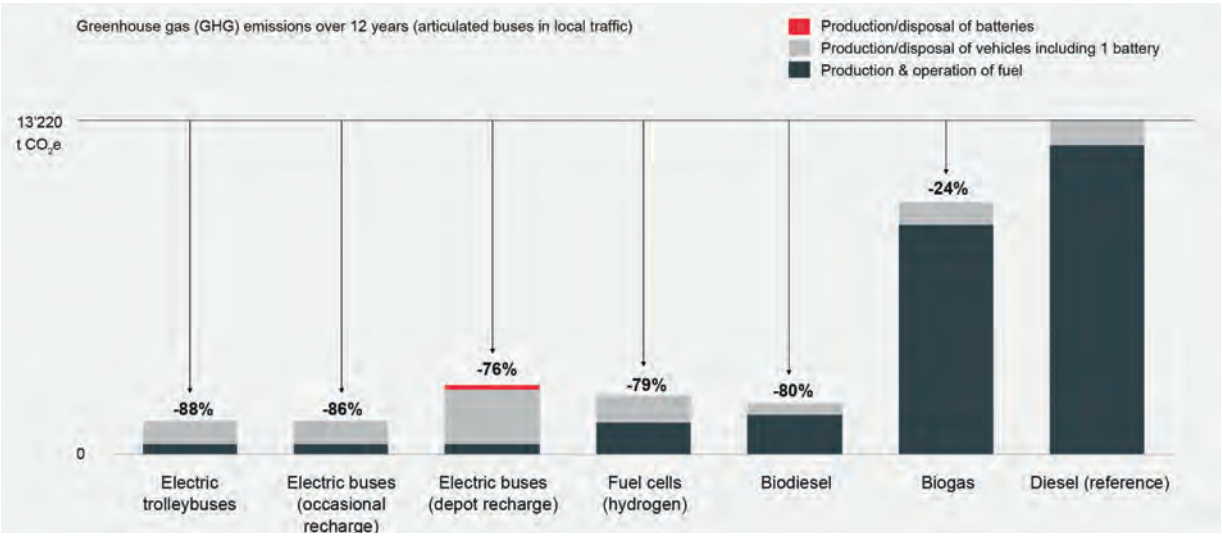
Control over the two key elements will enable the orchestrator to identify the optimal mix of different mobility modes, create an overarching vision, and set target KPIs to meet consumers' mobility requirements.

Successful collaborations will be essential to deliver better and more integrated transport solutions in the future. Cities will turn to private players to access their skills, expertise, or technologies.

Because the goal – a radically transformed transport system – is several years away and is still in a state of flux, new partnership models that work for both the public and the private sectors will be needed.

Even in this case, Hitachi can be the logical partner of choice. Hitachi's experience on IoT and big data analytics is demonstrated when connecting devices, assets, vehicles and all data sources (including external big data such as weather conditions) with the aim of applying advanced techniques such as machine learning and artificial intelligence to model, simulate and forecast patterns and behaviors.

Greenhouse gas emissions from buses in local traffic over 12 years



Source: INFRAS 2020.

On the 9th June 2021, the company announced the launch of a trial for a congestion monitoring system on city buses in Genoa. This had the aim to help mobility across the city, and was in collaboration with the local public authority, AMT.

This state-of-the-art system provides live and up to date information on congestion across the network and crowd levels on individual buses. The web portal will allow AMT to constantly monitor the crowd level and location of vehicles and reconfigure their services to more accurately anticipate passenger demand. The new system will operate on 11 buses on Line 3 of the network, a route of 49 stops.

The trial, which will run until March 2022, is testament to the leading role both Hitachi Rail and AMT are taking in embedding digital innovation into public transport delivery. It will initially focus on implementation of the web platform and analysis of the first pieces of data, before being rolled out for use on passenger services.

As shown, municipal authorities will most likely become orchestrators of the urban transport ecosystem, collaborating with private companies to create a more integrated transport network.

E-Buse & charging infrastructure

Green mobility stands out as a huge opportunity for cities, which will be tasked with driving electrification in the transportation sector.

Public and commercial transportation fleets, such as buses (and delivery vans and trucks), will play an important role in leading the way to the electrification of transportation because they are more likely to become electric sooner than personal vehicles. As commercial vehicles have higher utilization, fleet operators can realize a faster recovery on electric vehicle investments due to the lower costs of operations and maintenance.

The Italian bus fleet for public transport presents an average age significantly above the EU counterparts -10.5 years vs 7 years (CDP, ASSTRA, 2019. Investire nel TPL) – thus it is characterized by high fuel consumption and carbon emissions. 90% of the local Italian bus fleet are petrol, diesel and dual fuel vehicles and more than 40% are high emissions vehicles (i.e., Euro 0, Euro 1, Euro 2, Euro 3, Euro 4).

The high average age of the fleet represents a critical element: it means an increase in the operating and maintenance costs (e.g., the average maintenance costs of a new bus are 6 times lower than those of a 15 year-old bus).

To overcome this, the Italian RRP intends to achieve a reduction of 66% in 2026 of GHG emissions from renewal of about 10% of the existing bus fleet.

Such objectives will be achieved through the renewal of buses that – if supported by the realization of the dedicated infrastructure – would lead

to the disposal of all Euro 0, Euro 1 and part of Euro 2 (about 60%) of buses for local public transport by 2026.

Electric buses are quiet, produce low emissions compared to diesel buses, and consume two to three times less energy than a diesel or natural gas bus equipped with a combustion engine.

Specifically, the GHG emission reduction potential for electric buses powered by renewable electricity is estimated between 75% and 90%.

However, fleet managers often have concerns about investment costs, vehicle choice, charging infrastructure, battery technology and operational impact. New technology and new models of buses, batteries and charging devices are constantly emerging, creating a bewildering choice. In many cases, depots will need to adapt to make space to charge multiple vehicles overnight and the local grid network may need to be reinforced to provide sufficient electricity supply. For fleets with over a thousand buses, the charging infrastructure and related costs alone will likely be millions, with the return on that investment some years down the line.

When the transfer to electric vehicles does get underway, fleet managers will have a new set of data, which will be substantially richer than is available for ICE models. Expertise in data analytics in order to best utilise the data is key to making the change successfully. For example, nationwide commercial fleets need carefully designed networks of charging stations with optimized scheduling so that costs can be minimized with off-peak charging – a system that will rely on advanced analytics.

Therefore, as the pressure to decarbonise the fleet increases, finding an organisation with the required blend of experience, skills, and capability to support the planning and execution of the migration is important.

Hitachi is perfectly positioned to support public transit authorities and commercial fleet operators to go electric with minimal disruption to operations. The company has over a 100 years' knowledge of the automotive industry, 25 years of fleet management experience, over 50 years in IT solution development and systems integration, and is an industry leader in grid to plug infrastructure, V2G and smart charging technologies. By combining this knowledge and experience, Hitachi recently created an offer called Intelligent Fleet Decarbonisation (IFD).

Hitachi's Intelligent Fleet Decarbonisation service is designed to de-risk the entire fleet electrification process by creating a Total Cost of Ownership (TCO) model for the entire electrification project. This extensible TCO model drives the transition strategy, building the business case to prioritise what and when to buy, optimising operational costs and calculating when a return on investment can be realised.

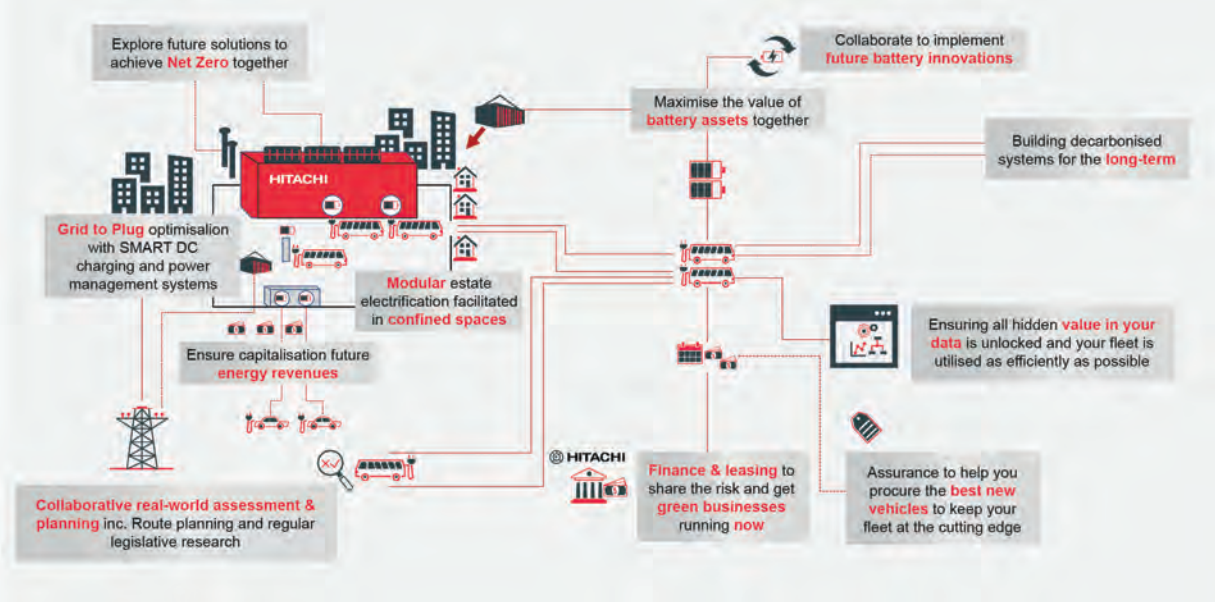
Hitachi ABB Power Grid has a product portfolio that includes grid integration, power quality and automation solutions, grid edge technologies, battery energy storage technologies, flash charging systems, and a fleet charging solution. Hitachi ABB Power Grids' Grid-eMotion TM Flash introduces the concept of virtual infinite range for the Bus Rapid Transit (BRT) systems operated with e-buses. Grid-eMotion TM Fleet is a scalable, modular, customizable solution for the large-scale EV charging of public and commercial fleet vehicles. Grid-eMotion TM Fleet reduces space requirements in fleet depots by up to 60% and optimizes energy consumption from the grid through an integrated digital system. The solution offers flexible connection to the utility grid and ensures compliance with power quality requirements. Available charging infrastructure can deliver a fully integrated solution with multi-output charging points between 50 to 600 kilowatts per outlet and are designed to ensure full interoperability with current and future EV fleets.

Leading the way towards the future of electric transportation, solutions such as Grid-eMotion TM can help to optimize the grid by shifting demand to off-peak hours, helping accommodate the increased demand while minimizing the need for modifications to current infrastructure.

In addition, Hitachi Europe delivers a suite of digital tools to manage and optimise fleet operations, utilising the telemetry available across ICE and electric buses, to form a dashboard for on-going bus fleet operations management. This includes tools to inform fleet managers of specific component performance that might lead to unplanned downtime, reporting of maintenance incidents to reduce risk of breakdown, detecting faults to support root cause analysis, and optimising planned maintenance based on need.

Hitachi is already supporting cities in the transition to electric with the Optimise Prime EV trial in the UK. Currently, London and the South East

Hitachi's Intelligent Fleet Decarbonization Solution for EV fleets



Source: © Hitachi, Ltd. 2021. All rights reserved.

is playing host to the world's largest commercial EV trial. Optimise Prime is using IoT technology to track the charging activity of up to 3,000 commercial vehicles. It is endeavouring to unearth the potential issues surrounding the large-scale uptake of EVs whilst developing solutions for smart depot and home charging.

The project is a truly collaborative effort. With the backing of UK energy regulator Ofgem, Hitachi, UK Power Networks, Royal Mail, Centrica, Uber and Scottish and Southern Electricity Networks are working together to collect and analyse data from the vehicles. Hitachi Vantara is designing, building and operating the project's IoT platform which manages data from the vehicles. Hitachi is also coordinating the projects workstreams and developing solutions to optimise the charging of EV fleets at depots, allowing more vehicles to charge within the network's existing capacity.

This will be the world's largest commercial electric vehicle dataset, and will help the project partners devise practical ways of overcoming the up-front costs that are currently preventing widespread commercial EV deployment, whilst reducing the cost of the EV transition for electricity bill payers. The dataset will be publicly available, allowing urban planners, power grid engineers and, of course, vehicle operators, to prepare for EVs.

With Intelligent Fleet Decarbonisation, Hitachi Europe's goal is to deliver an "As a Service" end-to-end solution, beginning at the grid connection and ending at the vehicle, covering the physical assets (vehicle, charging infrastructure, battery) as well as operational and maintenance services enabled by digital solutions.

We aim to achieve this by adapting the approach taken by Hitachi in rail operations encompassing trains as-a-service to build a similar as-a-service solutions, to help drive fleet decarbonisation and net-zero fleet operations in the coming future.

4.2.3. Environment and territory: act locally, impact globally

Rising anthropogenic greenhouse gas (GHG) emissions contribute to global warming and thus to climate change, which run parallel to natural climate variability.

Territorial development is very important for dealing with climate change and variability. It is capable of reducing regional vulnerability to climate change and mitigating against the impacts of climate change.

The potential impacts of these changes differ greatly between regions. Not only are some regions more exposed than others, but how climate change affects them differs.

Italy is very vulnerable to extreme meteorological phenomena and hydrogeological catastrophes, and that infrastructural weaknesses in water management generate environmental and health impacts that create considerable costs, and loss of income for the Italian economy.

According to the data collected by the Higher Institute for Environmental Protection and Research (ISPRA) and reported in the Report on hydrogeological instability in Italy (2018 edition), 7,275 municipalities (91% of the total) are at risk from landslides and/or floods; 16.6% of the national territory is classified as particularly dangerous; 1.28 million people are at risk of landslides and over 6 million at risk of floods. Climate change and short-sighted planning have made the territory subject to increasing risks and problems that affect the lives of citizens. These now require careful management to avoid currently abundant resources becoming rare.

Therefore, in order to improve the protection of the territory and the effectiveness of investments in land and water infrastructures, the Italian RRP aims to:

- Strengthen the forecasting capacity of climate change effects using an integrated surveillance/monitoring system to deploy both preventive measures and optimization/emergency measures.
- Ensure for the sustainable management of water resources and the improvement of the environmental quality of inland and maritime waters.
- Safeguard the biodiversity of the territory through the protection of green and marine areas and soil.

Hitachi, having placed digital transformation through DataOps, IoT and BigData at the center of its business modernization, is a key partner in helping organizations to monitor and govern the infrastructure and technology networks distributed across the territory.

Territory and natural events monitoring

Nature and territory cannot be governed, but information gathering through field sensors, analysis of conditioning phenomena, and study of predictive models can help in choosing the appropriate action needed to protect the territory, its resources and its inhabitants.

Many territories and natural events are monitored, with the objective of preventing environmental disasters by reducing the consequences of human activities. For example, hydrogeological instability – landslides, mudslides, floods – is impacted by natural and meteorological phenomena, but also by human activity. Withdrawal of water from water basins, pollution, poaching, fishing and acts of sabotage or terrorism all impact the environment. Field sensors can also be used to monitor earthquakes and tsunamis or help mountain ecosystem protection. The list of opportunities with this innovation goes on.

The digitalization of the sensors offers many opportunities – there are environmental, meteorological, inertial and kinetic sensors, chemical-physical parameters detection and wearable devices (for example on fauna). Sensors and devices connect in real time to Hitachi's Lumada IoT Platform. These smart devices, powered by Edge Computing, enable new frontiers of alert and action in the field. The Lumada IoT Platform has the task of connecting and managing sensors and field devices, and finds its maximum value if integrated, enriched and correlated with all the information, providing a 360 degree representation of the territory.

A special category of sensors to "see" what happens on the territory uses Hitachi Lidar ToF cameras and sensors (the latter GDPR privacy-compliant). Through Lumada's artificial intelligence, patterns and behaviours can be abstracted and monitored over time to develop predictive models and trigger alerts (e.g., against intrusion, sabotage and poaching). Information from the field can be analysed by using it alongside other information available in databases.

In the IoT data lake, external big data, such as the weather forecast is also crucial. Lumada can analyze historical data to identify predictive models and simulations based on environmental and weather readings. This allows for prevention opportunities thanks to alerts, forecast analytics and scenarios that are configured by the applied models. Lumada offers workflow automation systems following alerts, such as the activation of intervention orders, or reporting to Public Safety, but of course allows data visualization for monitoring and strategic decision support in Control Rooms or business analytics environments.

One example is at Autorità di Distretto Idrografico dell'Appennino Meridionale, which is building a unified data architecture, using data from field sensors, video surveillance and weather forecasts offered through a control room connected to Pubblica Sicurezza systems.

The data is flexible and reliable due to its heterogeneity, volume, continuous flow in real-time, and immediate availability. Hitachi use the data infrastructure and hybrid cloud market to support its customers towards the next generation of infrastructure.

Another example comes from the collaboration between Hitachi and Rainforest Connection, a non-profit that uses real-time data to enable partners to prevent deforestation and poaching. With both companies sharing the common ideals of social responsibility to the environment, Hitachi and Rainforest Connection established a partnership in 2019. The companies have worked to develop a unique solution that uses eco-acoustic data to predict illegal logging in the world's rainforests.

Every two seconds, an area of rainforest the size of a football field is destroyed, resulting in the extinction of hundreds of animal and plant species every year, contributing to droughts, and threatening reserves across multiple continents (WWF). Deforestation accounts for 10% of all worldwide carbon emissions, making it a massive contributor to global warming, with up to 90% of deforestation attributed to illegal logging.

Rainforest Connection builds devices called "Guardians" that are installed high in the rainforest canopy to collect acoustic data from the rainforest. The company detects chainsaw sounds in real-time and sends rangers an audio file to review and verify, and a grid reference to stop the illegal logging. However, this entire process can take up to 14 days and, in some cases, trees are lost by the time rangers arrive.

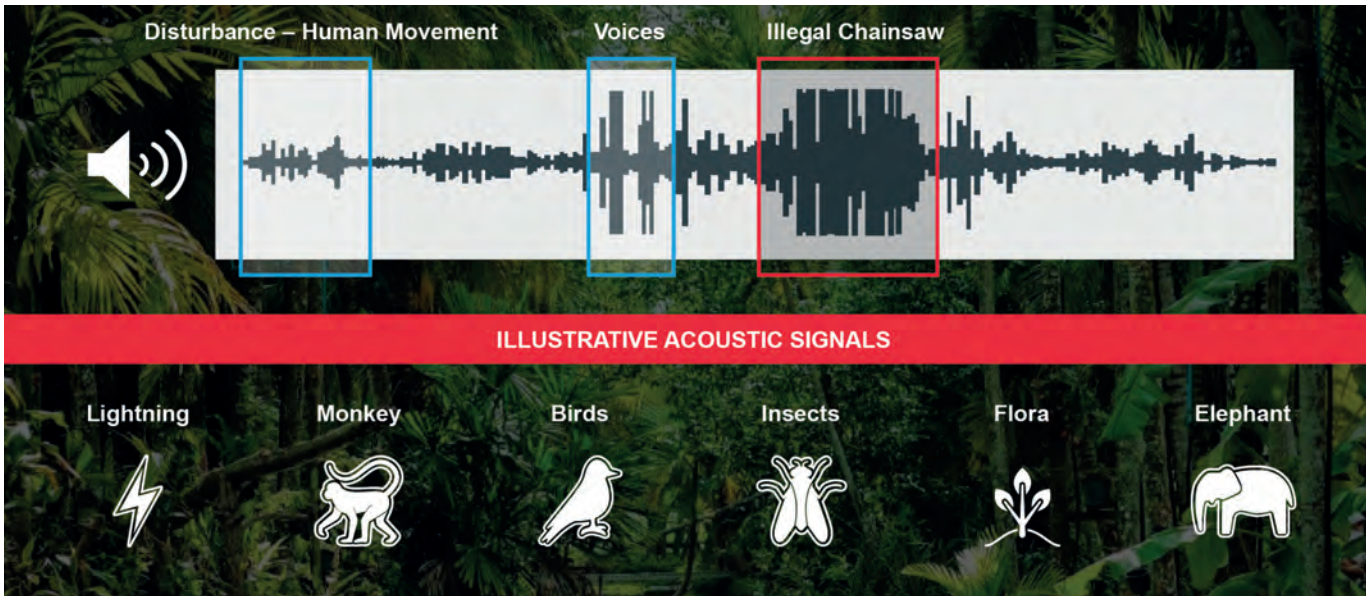
Hitachi has created a new solution to help predict illegal rainforest activity and shorten rangers' time to get on site. Using Lumada data analytics technology, Hitachi built algorithms that create a baseline of rainforest sounds. This simplifies and accelerates the process of identifying acoustic anomalies. For example, before starting a chainsaw, loggers will typically scout appropriate locations. Their presence causes a change in the sounds of the rainforest and signals a disruption to the environment.

Hitachi's solution detects these advance warnings and alerts rangers in real-time. Rangers use this technology get up to 5 days lead time to arrive on site. This head start gives rangers valuable time to pre-position themselves and prevent even more deforestation than they can today.

Hitachi and Rainforest Connection have since worked together to co-create and design the bio-acoustic solution. The solution is now live in Sumatra, where over 70% of all deforestation is because of illegal activity. The solution is scheduled to rollout in 2021 to the entire network of Rainforest Connection guardians, located in over 11 countries.

DataOps, IoT and BigData Analytics for Territory monitoring: Hitachi's solution overview

Hitachi's bio-acoustic technology to help prevent illegal deforestation



Smart water management

Water resources and how they are managed impacts almost all aspects of society and the economy – health, food production, security, domestic water supply, sanitation, energy, industry, and the functioning of ecosystems.

As global water demand rises, driven by rising populations and economic development, the challenge is not just simply to secure the water resources needed to meet this demand, but to use these resources with minimal waste. However, in many regions, a large amount of the water supplied from water treatment plants is lost due to leaks and other factors before it reaches end users in factories and households. In some areas, such water accounts for more than 30% of water sup-

Gajen Kandiah, CEO of Hitachi Vantara, presenting Hitachi collaboration with Rainforest Connection, May 2021

You might not think saving the world's tropical rainforests is a data challenge, but the urgent task of protecting the last remaining 2 million square miles of forest is precisely that.

Logging, much of it illegal, strips the planet of more than 32 million acres of natural forest every year. If you ever imagined literally trying to find a needle in a haystack, then you might be able to contemplate what it is like to find a chainsaw in forested areas the size of Australia.

Even if you could position a listening device where it could protect every tree, the scale of the rainforests means it would take weeks for preservationists to reach an illegal logging site. One and one-half acres of rainforest are lost every second, so the speed and accuracy of interventions counts. At the current rate of decline, it is estimated that tropical rainforests could be wiped out as functioning ecosystems in less than 100 years.

For the last two years, we have been working on

ply. The higher the rate of non-revenue water and the greater the loss of tap water, the more difficult it becomes to manage the waterworks business. This can have a wide range of negative effects, including rapid increases in the water fees charged to consumers.

The call to raise awareness on the issue of water is particularly relevant for Italy, which registers high consumption and even higher losses in the national water system.

Italy, in fact, is the first country in Europe for tap water consumption – 419 litres per inhabitant per day, against an average consumption of 200-250 litres in the rest of the continent. According to the WHO, Italy uses 30-35% of its renewable water resources, with an increase of 6% every 10 years. A trend that, combined with urbanization, pollution and the effects of climate change, such as increasingly frequent and persistent droughts, puts a strain on the country's water supply.

In addition to high consumption, which must be corrected if only for ethical reasons, more worrying are the high losses in the national water distribution network. The gap between the water put in the distribution networks and the water actually supplied, ranges from an average of 26% in the cities of Northern Italy to 34% in those of Central Italy, up to 46% in the cities of the South (Legambiente).

Among metropolitan cities, from 2014 to 2019, only Bologna, Florence, Milan and Turin remained below the national average of 37%. In southern regions such as Campania and Calabria, losses on the water network can reach up to 70%, combining with the almost non-existence of wastewater treatment plants (Utilitalia).

Even in irrigation use, the losses are very high and the possibilities for improving efficiency are significant.

Therefore, reducing the infrastructure gap in the water system which divides the South from the North of Italy is an absolute priority.

To this end, the Italian RRF estimates investments of over €2.2 billion to be made in conjunction with important reforms, directly impacting the governance of the water resource.

"Intelligent" maintenance is required, using digital tools to completely transform the network into a "smart network" which will efficiently reduce leaks and increase the resilience of systems to climate change.

Italian Water Utilities are consequently challenged on water lifecycle, water collection, transportation and sewage management and treatment. The integrated water cycle is creating connections between operations, customer support, and legal and regulation compliance. Therefore technological networks and plant monitoring through IoT

this challenge with San Francisco-based nonprofit Rainforest Connection as part of Hitachi's social innovation strategy. Our mission was to apply deep learning to review and verify audio files to see if we could reduce the 14 days it typically took for rangers to intervene and stop the loggers. Deep learning is a breakthrough form of artificial intelligence that uses data to write and improve software in applications as varied as self-driving cars and drug discovery. In the digital age, data is truly the lifeblood of discovery.

Together with Rainforest Connection, we developed algorithms that leverage a baseline of normal rainforest sounds to identify anomalies. Listening to the sounds of the rainforest and comparing audio files with 'normal' bio-acoustic signatures enables Guardians to detect and flag unusual changes in the rainforest's symphony – changes like the distinct sounds animals make (or don't make) when loggers scout potential sites.

Now, our algorithms give rangers 5 days' advance notice of a likely logging event, with 96% accuracy. This extra lead time allows rangers to reach potential logging before damage is done. With the help of deep learning and analytics, Rainforest Connection went from merely detecting illegal logging to predicting and preventing deforestation.

What's interesting is that it's not only the rainforests we can protect. In the fight for the environment, these algorithms and bio-acoustic technology can be applied across some of society's most pressing issues, for example, saving our oceans from illegal commercial fishing.

Moreover, if a rainforest can be successfully monitored and proactively managed, companies can make sense of the various signals in their business landscape and win the battle of data complexity. From a factory, to an airport, to an online shopping site, every terrain is filled with sounds that signal "normal" or "anomaly". The key is to listen.

is key to enable predictive maintenance, energy management, and operational efficiency. Hitachi is already helping Italian Water Utilities with integrated water management systems applying IoT, big data and artificial intelligence to help resolve issues. For example, it employs water supply operation information seeking to reduce water losses from leaks, enable efficient maintenance, and report on the quality of water.

An example of an innovative project to reduce the leaks, and increase the efficiency of the water supply network comes from the collaboration between Hitachi, the municipality of Oliena (on the island of Sardinia, Italy) and the main operator of Integrated Water Services in Sardinia. In 2016, Hitachi collaborated with the municipality of Oliena, a village with an aging water network with high levels of leakage and an intermittent supply, to find a sustainable solution to reduce water loss. Oliena's water supply is guaranteed by a natural source – a spring in the area called Su Gologone, one of the most important natural sites in Sardinia. The pilot project – "Oliena Model" – commissioned by the Integrated Water Services in Sardinia and completed with the support of Hitachi, has improved the water supply of Oliena by prioritising pressure management, air control and prevention of pressure variations.

Hitachi's solution is based on an audit and analysis of the existing water network, followed by technical enhancements such as network design, air and water pressure management, and leak detection. The expertise of the Hitachi team and the close collaboration with the partner stakeholders led to a framework of interventions that solved the existing issues and added stability to Oliena's water network. The water loss was reduced by more than 50%, and there were significant energy savings because of improvements to the main pumping station.

The success of the "Oliena model" – now on a list of Italian Best Practices for 2017 – has meant it has been implemented in other municipalities across Sardinia – 30 municipalities in 2017, 100 in 2018 and another 100 in 2019, saving water and improving supply for the entire island.

Another example comes from the collaboration between Hitachi and Madel, a leading Italian manufacturer of cleaning and body care products in the small town of Cotignola, 50km east of the historical city of Bologna.

Madel's manufacturing process used vast quantities of water and had to be treated at significant expense before being returned to the water network. The company also had high electricity consumption due to excessive use of water pumps.

By partnering with Hitachi, Madel tackled these issues head-on. Hitachi conceived and implemented a multi-faceted solution that combines the physical and the digital.

A Membrane Reactor[4] cleans the wastewater and removes the surfactant by products.

This allows Madel to do three things:

- Wastewater can be reused for production, reducing costs and the strain on resources.
- Wastewater returned to the network requires less treatment.
- The surfactant by-products can be retained and used to create new products.

On the digital side, Hitachi implemented its H-Vision cloud platform to optimise Madel's energy consumption. Through the Internet of Things (IoT), H-Vision constantly monitors energy usage including anomalies, consumptions peaks, alerts, flow inconsistencies, and the creation of baselines. Using these key energy indicators, it recommends

"Oliena Model": Hitachi Water Saving Project

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4 The Membrane Reactor combines a membrane for the ultra/micro filtration process that separates liquid from solid and surfactant components (oil, grease and other organic parts). Then a reverse osmosis process sterilizes the water. Finally, the treated water is controlled before releasing it into the sewer system. (Membrane Reactor is not a Hitachi product).

operations for energy efficiency, an area that Madel has found most valuable.

Utilising H-Vision in combination with the Membrane Reactor has given rise to both economic and environmental benefits, enabling Madel to reduce their energy and water consumption. They are now leading the industry through innovate technological solutions that challenge the sector to become more sustainable and help Italy move closer to achieving its Social Development Goals – Goals that seek to create a more prosperous future for the next generation of people.

5. CONCLUSIONS

The costs of natural disasters are on the rise. If unchecked warming continues, the consequences for human civilization will be severe. Rising sea levels could flood major regions before the end of this century and extended heat waves could threaten food security for a growing world population, whilst longer droughts could put drinking water access at risk. Extreme weather events and changes to current ecosystems could produce millions of "climate refugees" and cause a deterioration in global development and economic growth.

According to the Intergovernmental Panel on Climate Change, the per-capita impact of "no action" on global GDP has been estimated at minus 30% as of 2100. In other words, it would reduce global GDP per capita by 30% (vs minus 8% for 1.5°C of warming). This outlook, which is what will happen if nothing is done, dwarfs the economic costs that climate action has.

We must turn the trajectory of greenhouse gas emissions around to ensure that global warming stays within safe limits – ours is the last generation that can prevent global disaster.

The need for action is immediate, and action is possible. Most technological solutions needed to decarbonize our economies are available and costs for such solutions are falling.

It therefore falls upon this generation of business, government, and society leaders to accelerate action individually and through collaboration. All stakeholders – corporations, governments, investors and, ultimately, individuals – can lower their emissions, often with positive economic implications. Collective actions can support and amplify individual ones. Where the costs and risks of taking action for individual companies are higher (for example, in emission-intensive sectors), industry peers, value chain players or public-private partnerships can work together, sharing the burden.

Helping prevent global warming should be viewed as an opportunity for businesses, countries, and individuals build a better, more sustainable world. In this contest, Hitachi is taking decisive action at every level, increasing its long-term ambitions, and implementing more strong emission-reductive actions. As a true climate change innovator, Hitachi is investing in an Environmental Action Plan and planning to become carbon neutral by 2030 within all its production sites and by 2050 along its entire value chain.

As a champion in the Social Innovation Business and Co-creation – in power and energy, railways, electric vehicles, smart cities, smart buildings, smart manufacturing, and digital technology – Hitachi is also pushing the sustainability agenda by further innovating its green technologies and digital solutions to help governments, customers, and partners to address environmental issues, particularly CO_2 emissions reduction, and contribute to solving climate change challenges.

Hitachi has been appointed as a "Principal Partner" to sponsor COP26 (the 26th Conference of the Parties to the United Nations Framework Convention on Climate Change) which is going to be held in Glasgow, UK, this November. This is yet another strong commitment to Hitachi's role as a climate change innovator helping to decarbonize the world. As countries accelerate their efforts to achieve the goals of the Paris Agreement and the United Nations Framework Convention on Climate Change, we are proud to play a part, together with the UK government.

With the aim of powering good in the world and creating a better quality of live for everyone, Hitachi will continue – thanks to its quality and reliability – to contribute to society through the development of original technology and products to answer society's challenges and realize a more comfortable and safer world.