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Energy Journal

Power to the Grids!

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Editorial

Power grids and technologies

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The energy sector is undergoing a profound global transformation. Its most important players are working to develop new business models, while the importance of system reliability has become paramount. Amongst the issues at the heart of the debate are the growing penetration of renewable resources, the digitalization of systems and infrastructure, prevention, and the maintenance of efficient electrical networks that are increasingly battered by the impact of extreme weather. In order to focus on a scenario in which electric power distribution and transmission are becoming vital to the energy transition, this issue of the Energy Journal will explore networks, in terms of resilience and as the focus of technological investments, to provide for a stable and innovative future.

We have dedicated our top story to climactic change and strategies against extreme weather. If the scenario remains unchanged, damage to critical infrastructure in Europe could multiply tenfold by the end of the century (from €3.4 to €34 billion) solely on account of climactic change. The greatest damage – caused by heat waves, drought, the flooding of coastal and inland areas, heavy winds and forest fires – concern the industry, transports and energy sectors, especially in Southern and Southeastern Europe. We will also examine possible countermeasures and the role of regulators.

Along with the reinforcement of electrical networks we will address the issue of investments in generated distribution. In the more industrialized countries, with technologically advanced networks, electrical system resilience and flexibility is achieved through the innovative opportunities provided by smart grids. And we have a focus on smart grids, a competitive market for the United States and Europe (the United States is the third largest exporter of T&D devices and components, after China and Germany). The digitalization of the electrical sector alone, understood as the convergence between communication networks and energy infrastructure, is estimated to be worth nearly US$1.3 trillion over 2016-2025, creating 3.45 million new jobs globally. And this is why utilities are starting to invest in internal systems, streamlining their IT architectures, simplifying their product portfolios and optimizing operative processes. The objective is to be able to make decisions rapidly, on real-time data, with processes that address the new needs of clients and employees.

In this scenario, experimentation is fundamental to ensure that the entire ecosystem has the maximum level of efficiency and reliability. CESI's recent acquisition of KEMA includes high-power and high-voltage testing, inspection and certification services conducted at sites in Arnhem (Netherlands), Prague (Czech Republic) and Chalfont (USA). The acquisition of these sites — in addition to the CESI ones in Milan, Berlin and Mannheim — will allow the two companies to unite forces, competences and assets and become the global leader in the "Testing, Certification and Inspections" Sector.

We have also asked Hervé Laffaye, newly elected President of ENTSO-e, the association that represents 43 electricity transmission operators from 36 European countries, for an opinion on the current role of network operators, about the current geographic challenges and the importance of cooperation. At the heart of the commitment of the European Network of Transmission System Operators for Electricity, is the Ten-Year Network Development Plan (TYNDP), developed to identify the most important projects in terms of EU energy and climactic objectives. In terms of US-EU partnerships, public service industries see electrification as a potential strategy to contrast the trend towards a decreasing demand of electricity; especially in the transports sector, which is considered by sector experts as a further distributed energy resource to provide system flexibility. Thus, the networks of the future will represent a competitive lever to bolster security and satisfy increasingly specific user demands.

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Issue 15 / December 2019

Contents

"Electricity does not centralize, but decentralizes."

Marshall McLuhan (1964). "Understanding media: the extensions of man"

News

Latest from CESI

KEMA joins Cesi!

CESI and DNV GL signed an agreement to transfer the ownership of KEMA Laboratories to CESI. Once finalized the transfer, CESI will become world leader for independent testing of advanced technological components for the energy industry. The Company will extend its range of services with laboratories in the Netherlands, United States of America, Czech Republic together with its platforms in Italy, Germany and Middle East. The KEMA testing and inspections facilities include the world's largest high-power laboratory and the world's first laboratory capable of testing ultra-high voltage components for super grids, as well as the Flex Power Grid Laboratory, for advanced testing of smart grids components.

> **A world leader for independent testing of advanced technological components for the energy industry.**

Finalization of the JV with GCC ETL

In September 2019 CESI finalized the agreement with GCC ETL for the construction of the largest electric testing laboratory in the entire Gulf area. GCC Electrical Testing Laboratory is a joint-stock company owned by the main utilities, institutions and electromechanical companies in the Gulf region. The new laboratory will be located in Dammam and will be a key area for qualification and certification activities for all electromechanical components that make up the core electric systems and networks.

> **Closing of the largest electric testing laboratory in the entire Gulf area.**

Strenghtening the KYRGYZ energy strategy

CESI has been selected through an international tender to support the Kyrgyz Republic with its consultancy services to improve energy security and efficiency, expansion of transmission circuits and power generation in the area. In fact, currently Kyrgyz Republic Government needs comprehensive energy sector master plan setting the priorities, timing and costs associated with the objectives of pursuing the sector development. In this respect, CESI will develop forecasts, evaluate investments and train the staff in order to help the area improve its energy strategy.

> **Energy security and efficiency, expansion of transmission circuits and power generation.**

Special Aspenia issue with CESI

A special issue of the Aspen Institute *Aspenia* Magazine was published in November in collaboration with CESI. The publication addresses the evolution of technology and its influence on the future of human society with a special focus on energetic implications. In particular, in an article entitled "Convergent Roads to Energy Innovation," CESI CEO Matteo Codazzi analyses the key role that network convergence plays both for innovation and the future of the planet. The technological and economic convergence of electricity networks with water, natural gas and transport systems may contribute, in fact, to guaranteeing a more sustainable and efficient economy. Mr. Codazzi also emphasizes the importance of network modernization for the energy innovation sector and identifies two key concepts: decentralization and digitalization. Together with Mr. Codazzi, the special issues includes articles from various business personalities, including ENEL CEO Francesco Starace, who addresses the role of electrical energy to fight global warming, and the President of the MENA Clean Energy Business Council, Nasser Saidi, who emphasizes the importance of solar power to overcome our "dependency" on oil.

> **Network convergence plays a key role for both innovation and the future of the planet.**

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Top Stories

Resilient Grids to Fight Climate Change

**Over the next 20 years, a medium-sized utility company could lose as much as 1.7 million dollars due to missed revenue and the cost of reconstruction.
In order to prepare for this scenario, investments are necessary to reinforce electric transmission and distribution networks.**

It was the most powerful hurricane to hit the Bahamas since these meteorological phenomena have been measured. And the most intense to have landed in the United States since Labor Day 1935. During the first days of September 2019, Dorian, a Category 5 hurricane, caused unprecedented devastation. Its winds blew up to 350 km/hour and drove sea waves seven meters high. The rainfall was also intense and reached peaks of 7-800 mm (7-800 liters of rainfall per every square meter of surface). Over thirteen hundred buildings were destroyed in the Bahamas, causing millions of dollars in damage, while New Providence – the main island – suffered a total blackout. Notwithstanding the fact that Dorian lost significant force en route to the United States, becoming a Category 2 hurricane, and electric companies took measures to prevent black outs, thousands of people were left without electricity on the eastern coast of Florida. Previously, in September 2017, Hurricane Irma had left 16 million people stranded without electricity (15 in Florida and 1 in Georgia) after winds reaching 208 km/hour had overturned cranes, knocked over pylons and trees, and destroyed boats. And the Australian blackout of September 29, 2016 was no less cataclysmic. On that date, two tornados moving at 190-260 km/hour unearthed a 275-kV power cable causing a region-wide blackout.

Hurricanes, cyclonic rainfall, winds blowing faster than high-speed trains, temperatures plummeting dozens of degrees below freezing point. The climactic changes that have been observed since the 1960s are unprecedented according to the Intergovernmental Panel on Climate Change (IPCC), the UN Agency that studies climate change. These events not only negatively affect human settlements and nature, but also cause – and will continue to do so - extensive damage to electric power infrastructure. The point is that our current infrastructure was designed for different, less extreme climactic conditions.

In the “Special Report on Climate Change and Land” presented in Geneva in August 2019, IPCC affirms that violent rainfall, flooding, drought and desertification – events that are growing increasingly frequent – will be intensified by global warming.

India is paradigmatic in this context. The coastal regions of the Indian subcontinent have become more vulnerable to the multiple risks related to climate change. Intense and increasingly frequent cyclonic storms (most recently: Fani, Gaja and Hudhud) and extensive flooding have caused enormous devastation. In April 2019, Cyclonic Storm Fani devastated 500,000 houses and 6700 hospital buildings, as well as seriously damaging the electric power infrastructure. In the District of Puri, as well as in parts of Khurda and Bhubaneshwar, the grid was completely destroyed, leading to a total loss of 500 billion rupees (6.3 billion euro). Studies and analyses assessing the damage estimate that it will take 5-10 years to reconstruct these coastal states. While a series of efficient prevention strategies have contributed to saving many lives, there still are significant challenges related to the reconstruction of damaged infrastructure and a return to normality. Last August (2019), Aparna Roy, a researcher at the Centre for New Economic Diplomacy (CNED) and Energy and Climactic Change Expert, published a paper entitled “Making India’s Coastal Infrastructure Climate-Resilient: Challenges and Opportunities.” The paper indicates that the failure to plan for climactic resilience as part of infrastructural development – together with critical issues related to funding and the development of models for future scenarios – is one of the main issues that must be faced in the short term. Roy’s paper also presents many other suggestions.

It is fundamental that the government and regulatory authorities integrate measures for resilience into their infrastructural plans, possibly through partnerships and multi-stakeholder actions with organizations such as ACCCRN (Asian Cities Climate Change Resilience Network).

It is equally important, in order to attract private investors (especially after the initial phase, usually supported by public funding), not only to develop analyses and maps, but also to study models of climactic change impacted by integrating innovative technology, scientific applications and geological and hydrological studies. Last but not least, governance. The success of any plan for infrastructural resilience strategy calls for the involvement of local policy and communities that are directly interested in having a fully working electric power infrastructure.

> **“The success of any plan for infrastructural resilience strategy calls for the involvement of local policy and communities that are directly interested in having a fully working electric power infrastructure.”**

Infrastructural Damage

Giovanni Forzieri, a researcher at the European Commission’s Joint Research Centre (JRC), published an article entitled “Escalating impacts of climate extremes on critical infrastructures in Europe” in which he points out that, if nothing changes, the annual damage to critical European infrastructure could increase tenfold by the end of the century because of climate change (rising from the current €3.4 billion to €34 billion). The industry, transports and energy sectors – especially in southern and southeastern Europe – are at greatest risk of damage caused by heat waves, drought, coastal and inland flooding, storms and forest fires.

McKinsey estimates that, over the next 20 years, a medium-sized utility company could lose as much as 1.7 million dollars due to missed revenue and the cost of reconstruction. In order to prepare for this scenario, investments are necessary to reinforce electric transmission and distribution networks.

Response Strategy

An important contribution to climate risk management has been provided by Andrea K. Gerlak, Arizona University Udall Center Researcher, UNESCO Consultant and Environmental Issues Expert. In a report entitled “Climate risk management and the electricity sector” (based on 33 papers produced between 2002 and 2015, two thirds of which focus on Europe and the United States) published on Climate Risk Management, Gerlak and her team analyze the strong and weak points of the electric service industry, a sector that is particularly exposed to the impact of climate change.

Indicating a widespread lack of coordination and a fragmented approach to risk management, the authors highlight how the strategies adopted for actions addressing response, measurement methods and mechanisms to involve interested parties are divergent. The emphasis is placed on identifying the potential impact of climate change and opportunities for adaptation, but less interest seems to be devoted to the evaluation of risk and inter-sector collaboration for management activities. In order to overcome such a fragmented approach (and thereby increase the efficiency of climate change management and decision-making analysis), Gerlak recommends the adoption of a more “holistic” approach, including increased inter-sector collaboration and a closer partnership between researchers and electric utilities. In the aforementioned study by McKinsey, the authors indicate the importance of ex ante, rather than post facto, investment in mitigation activities. Indeed, as there already is a greater risk factor than previously expected (and forecasts point to increasing volatility), prevention brings not only social and environmental advantages, but also economic ones. There are different ways to adapt, based on geographical circumstances and natural environments.

The short answer is to make the electric power infrastructure more robust. Many enterprises have invested in reinforcing transmission and distribution infrastructure with the objective of preventing or reducing damage caused by extreme weather. In New Orleans, Entergy, which lost 95-125 miles of energy transmission lines to Hurricane Katrina, invested one billion dollars to improve the resilience of its substations, transmission and distribution lines, and ensure its resistance to similar strength storms. After Hurricane Sandy, which in 2012 hit the Great Lakes Area in the United States and Eastern Canada, Consolidated Edison (ConEd) implemented a plan

Global warming

In the “Special Report on Climate Change and Land” presented in Geneva in August 2019, the IPCC affirms that heavy rain, flooding, drought and desertification will amplify global warming over the next years.

Damage Caused by Extreme Events

Utility Average

Nexr **20** years

Loss in Profit and Costs for Reconstruction > US$ **1.7** billion

Strategic Plans for Electricity Network Resilience

Terna € **410** million

enel € **417** million

€ **830** million total

to reinforce its infrastructure, spending one billion dollars over the course of four years. The utility upgraded its relay panels and control systems, strengthened its overhead transmission lines, added the capability to isolate network sections (to reduce the number of clients affected by damage), and ensured that all new equipment in areas prone to flooding were capable of operating, even under water.

Even earlier, following the serious damage caused by Hurricane Wilma in 2005, Florida Power & Light (FPL) kicked off a long-term program to strengthen its network, spending over three billion dollars to protect its system from flooding, reinforce distribution adapters and substitute wooden powerline posts with new steel and cement structures. Simply reinforcing the grid, however, is not enough. In order to develop resilience and adaptability, investments are fundamental in distributed generation, too. This is electric generation produced by a number of smaller, decentralized production plants, powered by renewable energy, that contribute to significantly increasing system resilience. Moreover, in highly industrialized countries with technologically advanced electric power infrastructure, infrastructure resiliency can be increased by activating innovative smart grid functions such as microgrids and island modes. Micro-grids – distributed generation resources that function independently from the central network – were conceived to make individual clients independent and capable of self-sustainment if the main grid were damaged. Micro-grids may supply a specific site, such as a hospital, university campus or shopping center, or entire neighborhoods or rural areas. Indeed, during short-term emergency cases, micro-grids may allow the stable operation of larger grid sections that rapidly and automatically reconfigure to function as isolated networks. A network supplied solely by its own distributed generation limits not only loads, but can also employ local flexibility resources such as, for example, batteries. Lithium ion batteries improve network reliability and provide backup energy in case of damage caused by extreme climactic phenomena, as well as helping utility companies meet peak energy demands.

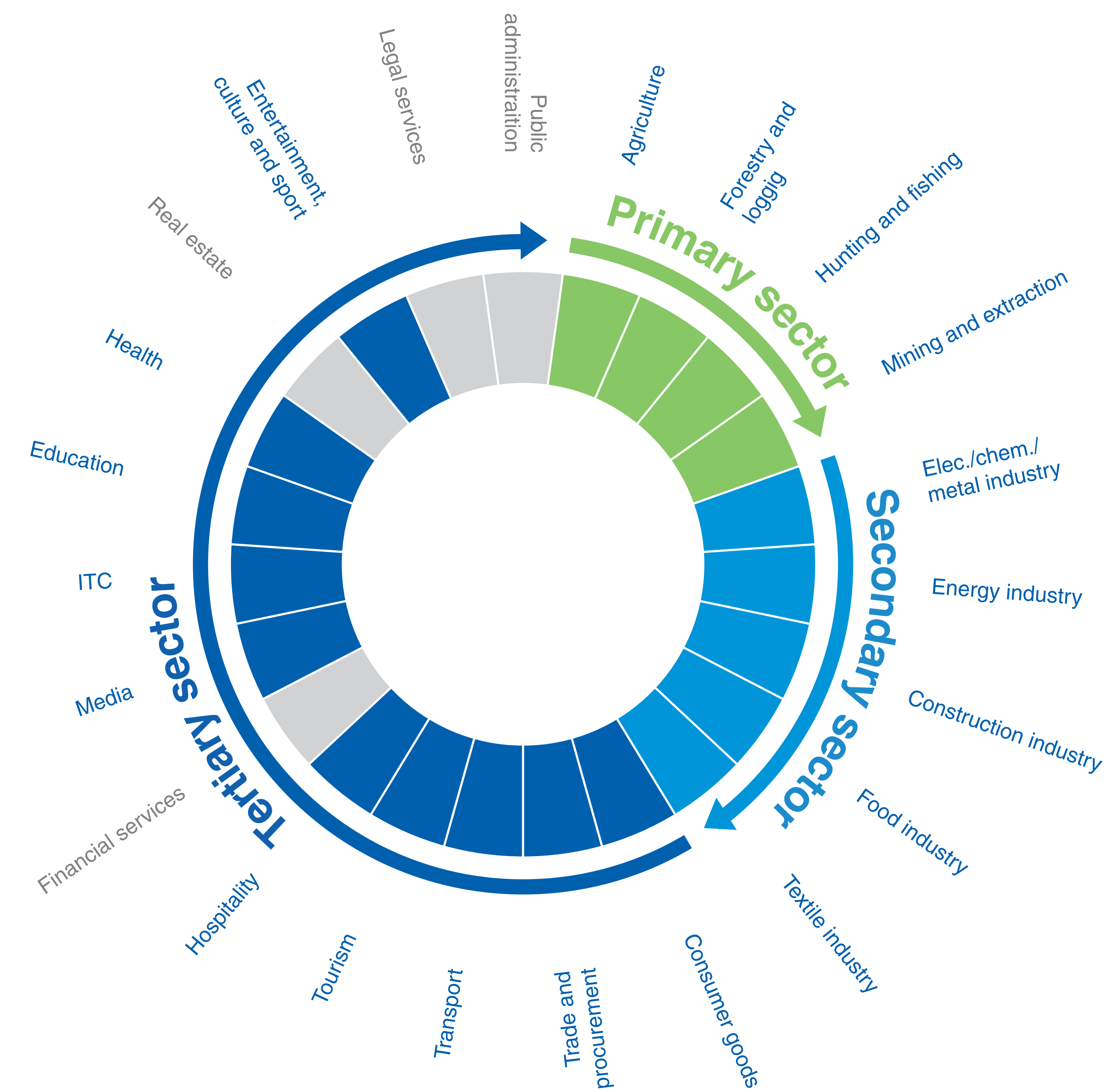
“This is electric generation produced by a number of smaller, decentralized production plants, powered by renewable energy, that contribute to significantly increasing system resilience.”

Investments and the Role of Regulators

Companies in the electricity sector do not only face costs related to the damage provoked by hurricanes and torrential downpours. In some jurisdictions, according to the McKinsey Report, utilities may also have to reimburse the economic losses caused by blackouts and power outages. And these costs lead to increased consumer rates, as happened in the United States Gulf Area, where, a decade later, clients are still paying for the damage caused by Hurricane Katrina. Public-private partnerships and partnerships amongst public utility services facilitate the financing of new investments in resilience. An important role is played by regulatory authorities, which can provide incentives for companies to develop climactic adaptation plans to protect and improve their infrastructure. They may encourage utilities to undertake preventive action and shift responsibilities if specific measures are adopted. Moreover, they may also promote experimentation and long-term planning.

For example, in a public document published in September 2018, the Italian Authority for Energy, Networks and the Environment (ARERA) proposed a system of economic incentives with rewards and penalties to stimulate actions dedicated to the resilience of the Italian electric power infrastructure. According to ARERA, independently from the increase in extreme meteorological

Energy input requirements for all economic sector



Grey words: weak energy input links
Blue words: strong energy input links

FOR EXAMPLE
In Thailand, a global temperature rise of 1.7 to 3.4 degrees Celsius could induce an increase in peak electricity demand by 6.6 to 15.3% by 2080. As temperatures increase, peak electricity demand on days of extreme heat waves increase requiring significant extra power capacity.

FOR EXAMPLE
In the electricity sector, resistance of copper lines increases by 0.4% and transformer capacity decreases by 1% for each degree temperature increase in Celsius.

> **Improved coordination will allow innovation, technological standards, adequate financial and risk-transfer tools, and a regulatory framework providing the necessary orientation for resilience and market regulation.**

events, the energy sector must demonstrate that it can resist external stress. Systems must be capable of "rapidly returning to their initial state following disruptions," whether the disruption is caused by intense rain, flooding, heat waves, drought or just a fallen tree. Regulations require Italian companies operating in the distribution of electricity to have a three-year horizontal resilience plan to meet both peak demand and have the ability to restore service during emergency conditions. More in general, in 2015, the World Energy Council's "World Energy Perspective - The road to resilience – Managing and financing extreme weather risks" had already highlighted the difficulties faced by governments in financing energy infrastructure.

In the report, the authors point out that new cost-benefit analyses are necessary to attract private investors. These analyses must illustrate the financial advantages of resilience activities, the stability of revenue and the ability to recuperate the cost of investments through regulated rates. Thus, regulatory policy and authorities play a key role in attracting private capital: besides providing guidelines and regulations for resilience and market regulation, they promote policies that open energy infrastructure to all investors. The WEC believes that collaboration amongst energy companies, project developers, banks, insurance companies, long-term investors, governments and regulators is fundamental, especially to comprehend the true impact that meteorological events continue to have on energy infrastructure. Improved coordination will allow innovation, technological standards, adequate financial and risk-transfer tools, and a regulatory framework providing the necessary orientation for resilience and market regulation.

The aforementioned document of the European Environment Agency (EEA) on the EU strategy to adapt to climate change bolsters this view. Together with private investments, the EEA recommends the development and use of tools for investors and insurers, who might otherwise

not sufficiently integrate climactic change into their risk management activities. In terms of resilience to atmospheric events, there are long-standing virtuous examples of collaboration in Canada. In 2010, the British Columbia Hydro and Power Authority, a utility seated in Vancouver that distributes electric energy to 1.8 million users, created a system that employs data from the Canadian Meteorological Center and National Weather Center in the United States to inform company decision-making processes. A thirteen-member team, composed of meteorologists, hydrologists, engineers, scientists, technology experts and analysts, operates on a 4.5-million-dollar annual budget. In coordination with the University of British Columbia, the team produces a daily forecast report to help company engineers optimize hydric resources dedicated to the production of electricity, as well as for environmental, recreational and other purposes, including ice modelling and the coordination of emergency response. Stephanie Smith, Manager of Hydrology at BC Hydro, emphasized to Ouranos (Climate Scenarios and Services Group) researchers, authors of the "Adaptation Case Studies in the Energy Sector" Report (2016), that "learning to adapt to climactic change is a long and complex." However, notwithstanding the objective difficulties and uncertainties, developing climactic resilience strategies and plans contributes to the reduction of the general vulnerability of energy infrastructure. And it "allows us to save millions of dollars!" Smith concludes.

Resilience: Enel and Terna's Plans

Enel and Terna, the Italian transmission system operator, have allocated nearly 830 million euro (respectively 417 and 410 million) to resilience actions - to reinforce their electricity networks, even against extreme climactic events - in their strategic plans.

The Annual and Multi-annual Development Plan for E-distribution infrastructure 2019-21 includes a section dedicated to increasing the resilience of the electrical network as per the forecasts of the Italian Authority for the Regulation of Energy, Networks and the Environment (ARERA). Over a three-year period, operations dedicated to resilience account for an investment of nearly 417 million euro, in addition to the 250 million euro already allocated by the 2017-18 plan. The operations planned by the ENEL Group Company to increase resilience will affect ca. 7000 kilometers of medium-voltage lines and bring benefits to nearly four million users. Actions to mitigate the risk of power outages will address the main critical factors that affect the network: the impact of ice on overhead power lines during the winter months, the effects of wind and trees falling on overhead lines, and the consequences of heat waves during the summer months. In parallel, the "Plan for Security of the Electric Power Infrastructure," which is drafted yearly by Terna and approved by the Italian Ministry for Economic Development, is a four-year program that defines initiatives to prevent and reduce the general consequences of power outages. Providing a total investment of ca. 803 million euro for the period between 2019 and 2022, the plan describes the operations necessary to safeguard physical network integrity. These include surveillance and protection activities for critical power stations and actions to secure IT infrastructure from break-ins, unauthorized access attempts and cyber-attacks. The document also includes a specific section dedicated to the physical resilience of the network and control system with a 410-million-euro investment over a five-year period. Besides using the "Defence Tower" (environmental data collection and transmission system), Terna must make its electric power infrastructure more resilient and capable of withstanding extreme climactic events. In fact, nearly all of its electric energy transmission infrastructure is exposed to the direct impact of atmospheric agents: heat waves during the summer months and heavy snow during the winter months, often accompanied by strong winds and sea storms on the coasts that may reach the same intensity as a Category 4 hurricane.

Scenario

The Convergence of Networks: Present and Future

Distribution system managers will remain fundamental for promoting the energy transition. The grid is key to this transformation as it connects generation and demand.

Imagine a world in which electric power transmission and distribution operators used the large amounts of data in their possession to schedule maintenance activities addressing the needs and risks of individual assets. Imagine a world in which priorities and programs were assessed on the basis of accurate predictions rather than on *ad hoc* post-event reports. Imagine a world in which network information and the management of resources were updated nearly in real time.

Indeed, a world in which the capillary circulation of data informs us about how electric power is used by households and companies already exists. According to Rui de Sousa, Solution Manager at McKinsey, operators could already be using this type of technology, but many of them have not yet fully grasped its potential. As an alternative to the routine preventive methods employed by most utilities, Sousa explains that predictive maintenance based on data collection (which helps to predict resource failure probabilities and address maintenance activities) promises greater precision and reliability at a lower cost. "In the context of a lean industry accustomed to annual gains of 1-2% in real terms, at best, we have seen operators reduce their costs by 10% in medium-voltage distribution grids, 15% in high- and medium-voltage overhead lines and underground cables, and 20% in high- and medium-voltage substations, while improving asset reliability."

The use of big data - and the application of artificial intelligence to infrastructure - is just one of the many elements that embody the digital revolution in the industrial sector. Technology is evolving exponentially and forcing companies to rethink their business models and strategies to remain key market players. In addition to the progressive decrease in the cost of new technology, the other great driver of change in the energy sector comes from the United Nations Agenda 2030 and its 17 Sustainable Development Goals (SDGs) that have become a benchmark on all five continents. The seventh SDG, which calls for access to affordable, reliable, sustainable and modern energy for all, aims not only to increase renewable energy quotas and improve energetic efficiency, but also to promote investments in energy infrastructure, expanding the system and updating the technology to provide modern and sustainable energy services.

New policies and investments must drive a renewal based on the convergence between electrical grids and information and communication technology. "We are living in an extraordinary age for global energy," points out Fatih Birol, Director of the International Energy Agency. "It is a sector undergoing great changes, in which the needs of civil societies will create a new, non-traditional energy system based not only on cost and reliability, but also on sustainability." And this is corroborated by a global demand for electricity that has nearly doubled. The average American user consumes ca. 13.200 kWh per year, three times as much as in 1960. Over the same period, power consumption in India has risen to 680 kWh per year per person from zero. Access to this resource is a trend generating global opportunities in the transports and heating sectors, still markedly characterized by the consumption of traditionally produced energy. The increase in electrification, explains Birol, poses a series of challenges: "The growing quota of intermittent renewables, such as wind and photovoltaic energy, means that future electricity markets must be based on flexibility. Besides scrupulous policies and regulations, the private sector and decisional bodies must cooperate closely to conceive the required market reforms, promote investments in renewables and distribution networks and extend the adoption of demand-response technology."

Describing the inevitable and profound changes that will be driven by technology and innovation, the World Economic Forum has identified three major trends affecting traditional electricity grids: electrification, decentralization and digitalization. In "The Future of Electricity - New Technologies Transforming the Grid Edge" Report, WEF Researchers (in collaboration with Bain & Company) explore how these three trends operate in a virtuous cycle that amplifies individual contributions:

1. Electrification of large sectors of the economy (such as transportation and heating) means that electricity will be critical to long-term carbon reduction objectives and will represent an increasingly greater quota of renewable energy;

2. Decentralization, driven by the decreased cost of distributed energy resources (DERs), will make customers active system elements, requiring significant coordination. The distributed generation of renewable

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energy sources, distributed storage to satisfy demand flexibility, energy efficiency and demand-response for consumption management are concrete answers to the introduction of new technology;

3. Smart technology and the advent of the Internet of Things will support the other two trends, allowing for greater interaction with clients and the real-time automated optimization of consumption and production. Digital efficiency will reduce emissions in a number of contexts, including the energy sector itself, as well as transportation, health, buildings, agriculture, education and industrial production.

Investments and Services

In planning strategies and pre-empting the shortcomings of their grids, utilities currently have the opportunity to reap the benefits of digital innovation to redesign the processes and systems that are not capable of staying abreast of the exponential pace of technology. Actions can be implemented to counter these trends and guarantee the presence of innovative infrastructure and new business models for the energy system of the future. Basic operations concern synergies between electric and digital networks (flexibility and data sharing), redefinition of the client experience, reforms necessary to redesign the regulatory paradigm and risk-management investments. These are the challenges that will drive companies to position themselves on the market with infrastructure and services aligned to the changes in act.

Addressing digital transformation, Adrian Booth, Senior Partner at the McKinsey Office in San Francisco, wrote that utilities should start investing on their internal systems, streamlining IT architectures, simplifying product portfolios and optimizing operative processes. Indeed, some companies still have obsolete management systems (“complex monolithic systems”) that will require an enormous cost and amount of time to update. Native digital start-ups, on the other hand, can make rapid decisions based on real-time information through software that is integrated with new functions every week and updated daily. This means that processes can be easily optimized to satisfy new client or employee needs. Governments and public services will also need to invest in modernizing the physical networks, especially to ramp up their resilience to catastrophic climactic events (see Top Stories). In the United States, this is a downward trend.

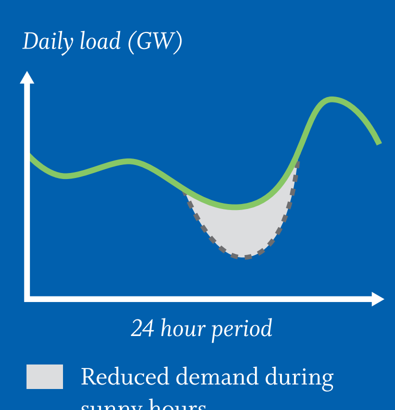
Notwithstanding significant incentives and public subsidies, American capital risk investment in new and renewable technology has decreased from US$5.7 billion in 2011 to US$2.2 in 2016. Nonetheless, distribution system managers will remain fundamental for promoting the energy transition. The grid is key to this transformation as it connects generation and demand, promoting the benefits of renewables and consumption over large areas. Thanks to advanced technology, network modernization plans will transform the infrastructure from a response-based system to one operating on independent and self-generating predictive models. In addition to modern and digital, networks must also be open, flexible and interoperable. WEF experts call for clarity on what should be considered “enabling infrastructure” (charging stations, broadband telecoms and smart meters, just to mention a few), as well as on ownership rules and cost recovery. “Having open standards and promoting interoperability between communication networks and distributed energy resources will ensure new services.” Charging stations for electric vehicles, smart meters, broadband communication infrastructure, network remote control and automation systems are fundamental for the development of smart services through the integration of distributed energy. Norway has stimulated the adoption of electric vehicles by creating a solid ecosystem of subsidies, including charging stations, parking benefits and other benefits with zero marginal costs, including the free use of carpool lanes for electric cars. In America, the Pacific Gas and Electric Company installed 7500 charging stations in Northern California. Tesla has a private charging station network to support sales of its electric cars, while Italian utility ENEL plans to install 7000 charging stations by 2020 - and 14000 by 2022 - for a total investment of 100-300 million euro.

Interoperability and open standards also guarantee that clients and third parties benefit from the data generated by distributed energy resources and digital networks. Connected devices and technology produce a large quantity of data that, if shared, has a tangible value. In the United States, the Department of Energy’s Project Green Button provides 60 million utility clients with easy and secure access to their energy usage information. And this data can be analyzed to identify more convenient on-line services. Thus, business models are shifting towards a new range of distributed resource management, supply, operation and installation services that benefit not only traditional utilities, but the final user, too. This allows networks to become platforms that maximize the full potential of distributed resources and allow for the exchange of services with other operators. Digital dynamics open up new prospects of inter-sector partnerships that are fundamental to success thanks to technological convergence and the superimposition of perimeters. In Europe, automakers and utility companies are collaborating on the development of business models on the development of energy storage facilities based on used battery modules, the increase of Vehicle to Grid (V2G) technology for ancillary services and the extension of electric vehicles in company fleets.

The future of energy

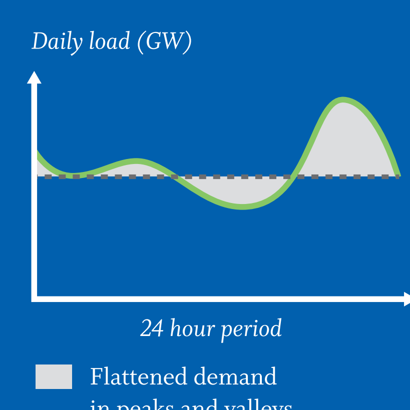
Distributed Generation

Distributed generation from renewable sources - primarily Photovoltaic (PV)



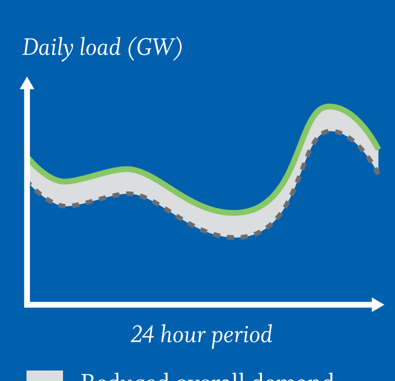
Distributed Storage

Devices that store electrical energy locally for use during peak periods or as backup



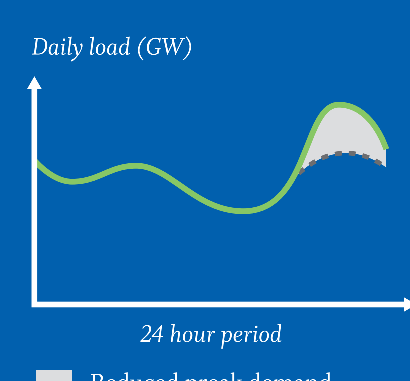
Energy Efficiency

Any service or device that allows for reduced energy use while providing the same service

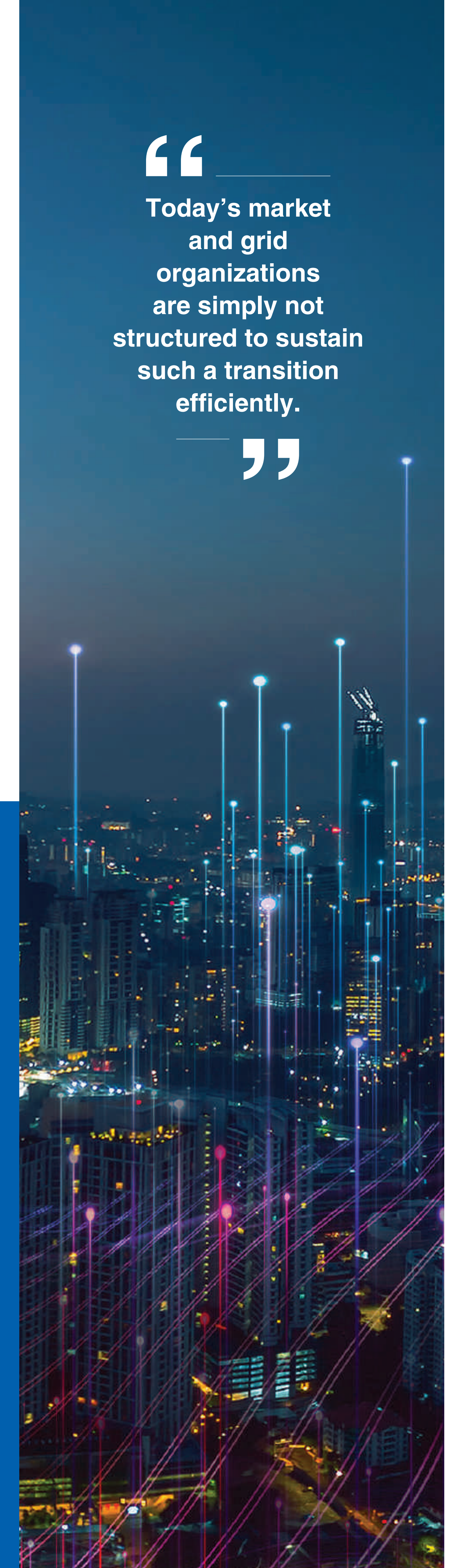


Demand Response

Technology that enables control of energy usage during peak demand and high pricing periods



The future of Electricity: New Technologies Transforming the Grid Edge. (Source: World Economic Forum in collaboration with Bain & Company. March 2017)



> **“Today’s market and grid organizations are simply not structured to sustain such a transition efficiently.”**

Realigning Regulations

Researchers at German NGO “Renewables Grid Initiative” have published a study on the sector that analyzes the outlook on the future, technology and regulation with 22 senior executives (16 TSOs and 6 DSOs) from 16 European countries. According to the participants, some elements in the current regulatory context should be considered obstacles to the development of networks both at the national and European levels. The report addresses authorization procedures (too laborious and complex), regulatory pressure to reduce costs (notwithstanding the need for new investments), the lack of support for environmental mitigation and compensation operations and insufficient regulatory foresight to incentivize system flexibility. One of the greatest barriers, according to the grid operators, is the lack of European alignment with the plans of neighboring countries and misalignment with the real world.

Current regulatory silos (regions – countries – cities, industries, sectors) must be overcome and new regulations are required to reassure investors and keep abreast of technological evolution. With regard to digital information management, political and regulatory authorities are beginning to develop new rules for possession, access to and sharing of data. In the United States, California, Colorado, Illinois and Texas, for example, have already adopted data privacy regulations to establish usage standards with third parties. In some countries, a central authority archives and manages access to data by interested parties. In Scandinavia, the data hub may be managed by the transmission system operator, while Germany and other European countries have opted for a decentralized model in which the communication standards do not allow network operators to collect and distribute data to eligible partners.

Looking to the Future

The “Just E-volution 2030” Report, recently published by The European House-Ambrosetti in collaboration with ENEL and the ENEL Studies Centre Foundation, explains how the entire European market for electricity, mobility and digital services (energy storage systems, smart network management, demand-response, sharing platform, Home-to-Grid, Vehicle-Grid integration) will swell to a value of nearly 65 billion euro. Safeguarding the industrial competitiveness of the European system and managing the technological transformation of the value chain will require reskilling and upskilling of a workforce with traditional competences that will have to gradually abandon industrial sectors that are no longer competitive and join more efficient ones.

Utilities need to invest in human capital, developing talent and providing for the digital education of their personnel; enterprises and policymakers must facilitate this with commitment and dedicated programs. Just as technology is transforming reactive networks into predictive ones, the digital transformation will help individuals to pre-empt change, rather than having to race to keep up with it.

Future & Technology

Smarter and Smarter: The Grid Turns Digital

Smart grids, besides being an innovative element for T&D networks and promoting the development of energy storage systems, continue to evolve as complementary technology to ICT networks.

Investments in the smart grid sector and the opening of new global markets are strongly influenced by political and legislative contexts. The United States is steadfastly modernizing its electric power system, but there are active investments throughout the global market, too. Global spending to modernize networks and develop smart grid technology will continue to increase, especially in the most innovative sub-sectors such as Smart Grid ICT and Energy Storage. According to analysts quoted in the "**2017 Top Markets Report Smart Grid**," published by the United States Department of Commerce, spending on intelligent networks will increase at an average annual rate of over 19% (2017-2022) reaching US$50.65 billion by the end of the period. Smart Grid IT – subdivided into data supervision and acquisition systems, emergency management, plant geolocation, management of distributed energy resources and demand control – will increase by more than 30% over the next decade, reaching US$21.4 billion in global annual investments by 2026. Grid-connected energy storage will grow at an average of 16% (2016-2025) reaching US$7 billion.

Many utilities in Europe, North America, Eastern Asia and Australia are investing to manage the lower consumption rates and the consequent decrease in profits that arise from a more efficient system, whilst also facing the increase in generated distribution plants on their networks. In some countries, especially developing ones, electricity theft is a major issue. Redesigning business models and identifying new forms of financing to modernize networks is a must for utility companies. Indeed, it is estimated that, **in Europe**, many utilities have **lost over 50% of their market value since 2010**. Investments are mainly focused on implementing advanced infrastructure for collecting and analyzing grid information – the so-called "big data" – to increase operational efficiency thanks to the progress achieved in data analytics and cloud computing.

The United States and Europe are competitors on the market for the application of smart technology to power grids. In fact, the USA is the third largest exporter of T&D devices and components, after China and Germany. At the same time, countries in Northeastern Asia,

> **"According to Navigant Research, more than 1.3 billion IoT devices are anticipated to be installed in the world's commercial and residential buildings by 2021."**

such as Korea, Japan and China, have identified the energy storage sector as strategic and government policy is promoting local companies, partnerships with American software companies and direct investments on the United States market. The digital transformation of the electric sector alone - understood as the convergence between communication networks and power infrastructure - is estimated to have a market value of US$1.3 trillion over 2016-2025, leading to the creation of 3.45 million new jobs globally.

The drive is strong, but there are issues related to the fact that many networks were designed to meet the requisites of a centralized generation model. Smart grids evolve by exploiting a range of technologies that can be implemented at different levels, although, to date, investments have mainly focused on specific areas. In Italy, for example, projects for renewable generation plants and electric meters have attracted most funding. Globally, various sources estimate that smart investments in the electric sector will increase from US$52 to US$64 billion by 2025. And this growth will concentrate on the most innovative segments: automated distribution systems (US$4-10 billion), management of household energy (US$1-11 billion) and flexibility, which in 2025 will be worth US$4 billion. In order to modernize the grid and transform existing infrastructure into a platform capable of supporting an energy cloud environment, the International Energy Agency (IEA) plans to invest US$7.2 trillion in transmission and distribution networks over 2012-2035. In particular, 40% of funds will go to substituting existing infrastructure, while 60% will be earmarked for the development of new infrastructure.

If, on the one hand, it's fundamental to create a responsible, digital culture by acting on demand, on the other, utilities must accept the fact that the **ways of generating electric energy are changing at an exponential speed.** In Italy, mainly due to the presence of small-sized plants and micro-generation, decentralized production and that deriving from renewable resources (not programmable ones, such as wind and solar energy) already accounted for 34% of total national production in 2018. This means that operators will have to manage a reduced demand for electricity. However, thanks to a more efficient use of energy, they will be able to sell new maintenance services, intelligent household consumption options and business and remote assistance services to clients.

Demand Response and Digital Services

American utility companies invested ca. US$144 billion on infrastructure for the generation, transmission and distribution of electricity in 2016 (most recent data available). More specifically, this included US$21 billion on the development

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of transmission networks and US$27 billion on distribution networks. In terms of smart grids, annual investments increased by 41% between 2014 and 2016 (US$3.4 - 4.8 billion) and should reach US$13.8 by 2024. On account of the high capital cost and the duration of the infrastructure, current investments must necessarily support a network capable of continuing to evolve technologically over the coming decades.

Participating in the ancillary services market, commercial clients, industries and other joint ventures have begun to access a new remunerative option by exploiting their generation plants and the consumable resources that can be controlled and modulated through demand response mechanisms. They have become active protagonists of a system that is environmentally more sustainable. For consumers, decentralization and the use of smart grids mean easier access to power, as has occurred in California where blackouts have been

decreasing over the last 15 years. Local electric networks – powered by small plants based on renewable resources, energy storage systems and demand control technology – allow power to be extended to developing countries, too, by contributing to the diffusion of photovoltaic energy production plants.

Demand response programs satisfy two of the **five business models of the circular economy**: resource sustainability and shared platforms. In terms of resource sustainability, load modulation compensates for the unpredictability of renewable resources, especially driving the diffusion of wind and solar energy. Although it's not really demand response, smart meter technology also influences consumption by implementing a range of rates that stimulate consumption of green energy. In terms of sharing platforms, active and passive users can be aggregated to contribute to saving resources, acting as a critical mass and developing a virtual capacity reserve that can be shared with the rest of the network. Advanced technology allows for optimized energy flows that integrate storage capacity and self-production and create peer-to-peer energy sharing mechanisms.

The forecast advent of millions of battery-based electric vehicles on our roads over the next decade will prove a true challenge for our grids, but it may also provide the needed impetus for demand response programs. Thanks to digital and technological progress, some services related to the energy transition are spreading and have a high development potential. On the basis of mobility-related services (energy storage technology, vehicle-to-grid, vehicle-to-vehicle, vehicle-to-home, sharing platforms, sensor systems), in the "Just E-volution 2030" Report, the **European House Ambrosetti** and **ENEL** estimate that the aggregate value of adjunct service production will reach **€250 billion globally** by 2030, of which €65 billion in the European Union, €6 billion in Italy and €4 billion in Spain.

Smart Grid ICT

Smart grids, besides being an innovative element for T&D networks and promoting the development of energy storage systems, continue to evolve as **complementary technology to ICT networks**. This subsector is developing advanced measuring infrastructure (in the 2017 Ranking on Smart Meter Penetration, Italy placed first globally at 100% followed by Finland, China and Sweden), the automation of distribution networks and substations, new analytical tools for promoting energetic efficiency, the aggregation of distributed energy resources and the development of connected intelligent networks.

The increase in the use of intermittent and variable (solar and wind) energy resources is forcing network operators to implement new ICT solutions that improve system planning and demand and supply forecasts. In the United States, in 2016, for a 17-hour period, **Texas produced 40% of its electricity with wind energy**. In Europe, on January 23, 2019, Spain satisfied 43% of its total electric power demand thanks to wind energy. Denmark has planned to eliminate fossil fuels from its energy mix by 2050. Germany has sufficient solar energy to generate 30% of its household electricity demand from renewable resources.

> "Residential control of temperature and home appliances is reaching a level of sophistication that was once only feasible for much larger industrial and commercial facilities."

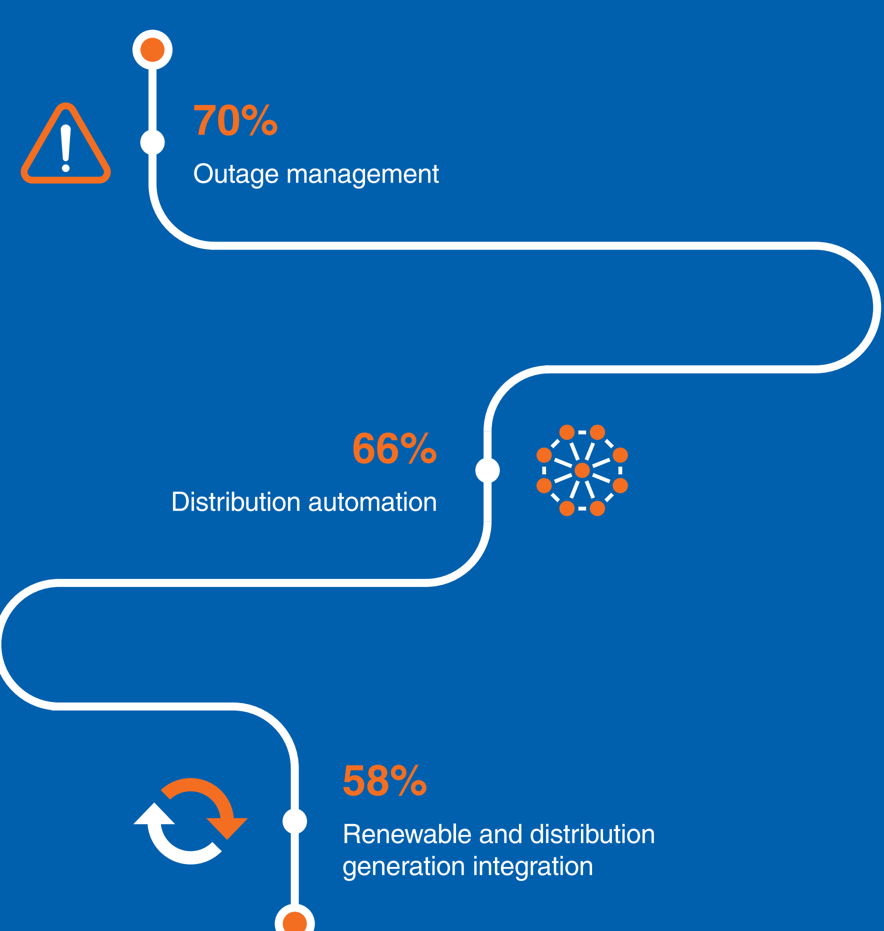
In parallel, smart grid companies continue to invest in **cybersecurity technology**, a market that has an estimated value of US$1.8 billion. In terms of distribution network substation management automation – whose implementation will reduce both the duration and cost of blackouts, the damage caused to equipment and the inconveniences for final users – Navigant forecasts that global investments will grow at an average rated of 49% over the next four years, reaching US$12.5 billion by 2021. And what about distributed generation? According to another estimate, the global market for so-called virtual power plants should increase by 30%, rising from US$191.5 million in 2016 to US$1.2 billion by 2023.

In terms of ICT smart grids, studies indicate we should not underestimate the impact of the rapid development of technology in a sector – such as the electric power industry – that is traditionally **shy in taking risks and therefore slow in driving the renovation of processes and infrastructure**. Another critical issue concerns the identification of common standards and platforms to promote the interoperability of hardware and software devices – an issue that has forced many utility companies to concentrate on system-specific, custom-tailored products. Yet another scenario issue is the lack of capital in the industries of developing countries, which suffer losses ranging between 20% and 40% in the T&D Sector.

Case Studies

Canada is one of the most advanced countries worldwide in the development of smart grids, also thanks to the transmission network it shared with the United States, a country with which it has a long history of cooperation and commercial partnerships, even on standards and interoperability. In 2017, Canada invested over US$ 700 million in smart energy technology, also gaining positions in areas such as smart meter installation that has been implemented in all its provinces and on nearly 60% of its national territory. Indeed, legislation addressing the energy sector in Canada drives the implementation of smart networks and promotes energetic efficiency as a tool for achieving the country's climactic and energetic policy goals. In terms of storage, Canada has installed over 57MW of electrochemical energy storage systems (75% of which are located in the Ontario Region) accounting for 2% of global production.

The top three digital-grid capabilities companies are investing in:



Top three digital grid capabilities invested in (Source EY, "Digital Grid: Powering the Future Utilities," 2016)

Today's grid VS the smart grid

Today's grid	The smart grid
Centralized, utility-controlled generation with traditional fossil fuels	Decentralized generation with emphasis on renewables and demand response
Blind operationof generation assets with only a forecast of demand	Real-time monitoring and advanced control of connected sources and loads for dynamic balance
One-way energy flows with little situational awareness and slow response to outages	Two-way energy flows that require automotion, outage management, and awareness
Manually switching to restore power based on trial and error	Self-healing grid that automatically prevents for minimizes outages
Passive and uninformed energy consumers	Better informed consumers actively participating with utilities
Focus on adding infrastructure (power plants, transmission lines, etc.) to meet demand	Focus on adding efficiencies and control to meet demand without building infrastructure
Static operating modes with minimal integration of operational data	Flexible operating modes with full integration of information and operational data
Grid is vulnerable to cyberterrorism and damage caused by natural disasters	Grid is resilient and intelligent, virtuality eliminating or mitigating all types of attacks

Another country at the forefront of ICT smart grids and energy storage is **Australia**. Thanks to the proactive role of its state and local governments, it has adopted far-reaching measures to modernize its energy infrastructure, reduce the use of fossil fuels and increase the adoption of renewable resources.

Researchers at the United States Department of Commerce predict that the recent blackouts in Southern Australia will drive an increase in short-term investments in the ICT and smart energy storage subsectors.

According to Ofgem, **Great Britain** will have to invest ca. £100 billion to satisfy its need for electric power infrastructure over the next decade. As one of the most interesting global markets for advanced smart grid technology and applications, the United Kingdom provides immense opportunities for innovators in the ICT and smart energy storage subsectors, even thanks to a highly competitive energy sector and recent commitments by the government and its regulators. Moreover, the current program of reforms could make it an important market for demand response and other smart grid solutions at the distribution and consumption levels. In short, in 2016, the United Kingdom, invested US$1.7 in smart energy technology for an average growth rate of 15% over a decade and an annual growth rate of 70% (2015-2016).

Yet another country that has implemented significant reforms is **Japan**, which has fielded incentives for distributed generation and demand response systems. Japanese utility companies are aiming to install smart meters on all 80 million Japanese households by 2025, a program that allowed Japan to overtake China in the 2015 ranking of smart meter investors. And this has allowed Tokyo to remain one of the main global smart meter markets, thanks to a number of investments in advanced technology for grid renovation, especially in the ICT smart grid and energy storage sectors.

Challenges and Barriers

According to analysts at the United States Department of Commerce, however, there still are a few key issues that may influence the development of intelligent networks, affect their rate of implementation and potentially slow down the competitiveness of the United States in terms of exports.

There is the issue of national protectionist policies, which look at the development of smart grids as a sector for economic growth, but one that is particularly **delicate in terms of national security and the transfer of sensitive data** between neighboring countries. In addition to this, there are issues on the definition of **international standards and interoperability protocols** for infrastructure, an obstacle to the diffusion of intelligent networks.

A further barrier is represented by the **cost of electricity and the regulatory context**. Both in emerging and advanced markets, explain the report authors, there is the need to develop a legislative framework that will support investments in intelligent networks and guarantee sufficient economic returns for the electric power industry. This is a challenge especially for emerging markets, where the attention to energy costs forces utilities, regulators and policy makers to develop creative solutions for investments.

> **"IDC predicts that, by 2020, one in four utilities will be integrating new sensor data and cognitive capabilities to boost their assets' efficiency and reduce maintenance costs."**

The objective is to overcome the cultural issues that new electricity consumers encounter when they must pay the bills for what they consider a common good and a due service.

Also of interest is the Italian V2G (Vehicle to Grid) program being tested by Enel X, the division for mobility energy of Italian utility company ENEL. The company has installed two bidirectional recharge facilities at the RSE Milan Headquarters to test the accumulation and transfer of electric energy for two electric vehicles (Leafs) provided by Nissan. The partners involved in the initiative point out that final users will only enjoy benefits from this service and the withdrawal of energy from vehicles will not in any way condition their habits.

V2G technology is already in use in some countries. Denmark was the first in 2016, where Nissan, ENEL and Nuvve launched the first full commercial global V2G hub. In Copenhagen, the Frederiksberg Forsyning utility company has installed 10 V2G ENEL units and added 10 Nissan e-NV200s (100% electric vans) to their fleet. When they are not in use, the vehicles can be connected to the V2G units to receive or supply energy to the national grid. Thanks to the Nuvve aggregation platform, the vehicles represent efficient mobile energetic solutions that contribute to stabilizing the Danish grid.

Opinions

Technological Innovation on the European Energy Scenario

Ten years after the creation of Entso-e, newly elected President Hervé Laffaye explains the commitment of the European Network of Transmission System Operators for Electricity, the association that represents 43 electricity transmission operators from 36 European countries, to guide the development and innovation of the energy system. How should the new challenges posed by the energy transition be faced? Laffaye has no doubts: "By waging everything on technological innovation."

Hervé Laffaye is currently Deputy CEO of RTE and is responsible for International Activities and European Affairs. He is also President of ENTSO-E.

His career started in R&D on applied mathematics for electrical systems. He has also held various operational management positions in gas and electricity distribution, before acting as head of the National Control Center during RTE's first seven critical years (2000-2007). Until 2016, he served as COO working on engineering, maintenance and operational activities at RTE.

1 *Good Morning Mr. Laffaye, the organization of which you are President represents 43 transmission system operators from 36 countries across Europe. In an energy transition scenario, what is the role of a network operator and manager today and how has it changed in recent years?*

Operators are responsible for a number of activities in the current energy scenario. First of all, they must guarantee the continuous, safe and competitive operation of the system.

Then, they must provide stakeholders with the outlook for the coming months, years and decades, so that they may prepare for the coming challenges and make all the necessary decisions. Finally, they also have to help operators to improve their coordination and facilitate access to the grid for all involved actors.

In fact, let's not forget that the current energy transition is not the first. In the past, the oil crisis had important consequences on the electrical system. However, the current energy transition comes with new challenges that are not only geographic, as it mainly affects continental Europe, but also concern the generation mix. Indeed, there are growing uncertainties on solar and wind generation, on new locations for offshore farms and possible interactions between TSOs (Transmission System Operators) and DSOs (Distribution System Operators).

This means that we need to immediately develop new infrastructure (not just in terms of lines and substations, but also of facts, storage, etc.) to address the current transition.

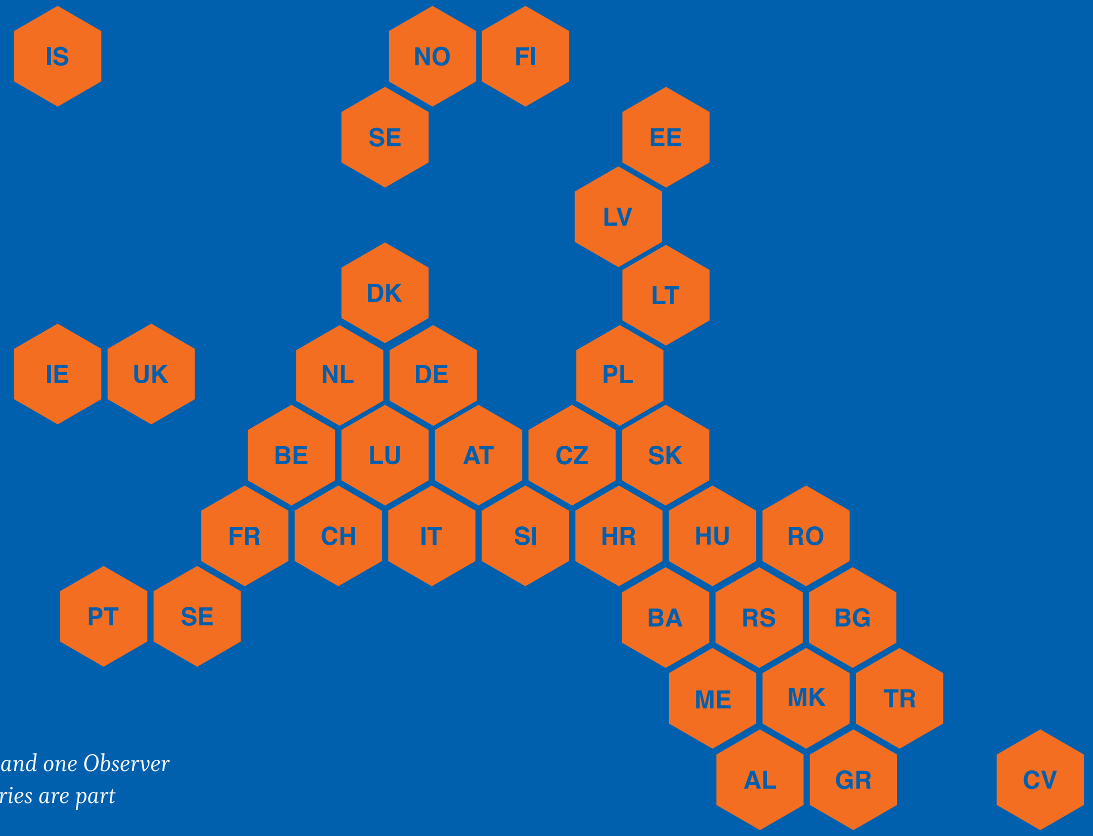
2 *Sustainability and the impact of energy systems on the environment are core issues. And there also is another one: the resilience of energy infrastructure to climate change. In Europe, how are we doing in terms of policies, strategies and investments?*

The issue of energy infrastructure resilience is mainly addressed at the national level by local authorities, so ENTSO-E is not directly involved in this issue. However, as a coordination platform, ENTSO-E promotes the sharing of good practices amongst TSOs.

ENTSO-E

ENTSO-E, the European Network of Transmission System Operators for Electricity, represents 43 electricity transmission system operators (TSOs) from 36 countries across Europe. ENTSO-E was established and given legal mandates by the EU's Third Legislative Package for the Internal Energy Market in 2009, which aims to further liberalize the EU Gas and Electricity Markets.

The role of Transmission System Operators has considerably evolved with the Third Energy Package. Due to unbundling and the liberalization of the energy market, TSOs have become the "meeting place" where players interact on the market.



43 TSOSs (42 Members and one Observer Member) from 36 countries are part of ENTSO-E

3 *You are an energy system expert. In your opinion, what is the outlook for smart grids and, more in general, on technological innovation? What trends will we see in European countries in the coming years?*

Innovation - and particularly digital innovation - is key to finding smart answers to the challenges faced by TSOs to boost the performance of existing assets (Dynamic Line Rating, for instance), to promote the exchange of information amongst TSOs, and to give stakeholders the opportunity to develop new data-based services. Let me mention that ENTSO-E has recently published a report reviewing 100 TSO projects on the so-called "cyber physical grid," which clearly demonstrates the growing importance of digitalization. Moreover, the energy transition is powerfully driving the development of Direct Current (DC) Grids in Europe, including offshore grids, of course.

> **"The approach of ENTSO-E is to be as transparent as possible, while ensuring that cyber security issues are anticipated and managed correctly."**

4 *One of the main activities of ENTSO-E is to guarantee maximum reliability for the exchange of data amongst operators, including through collaboration platforms. How can data transparency and security be managed with respect to external attacks? How is integration with renewables proceeding?*

ENTSO-E's approach is to be as transparent as possible, while ensuring that cybersecurity issues are anticipated and managed correctly, also in relation to the guidelines and rules of our members' national authorities, which requires us to keep a delicate balance, at times...

5 *The geographical perimeter of ENTSO-E extends beyond the borders of the EU and reaches 36 countries. What is the importance of cooperation amongst different regions today? What is the relationship between North America and the Mediterranean countries like?*

As Vice President of MedTSO, the Association of Mediterranean Electricity TSOs, I can assure you that the cooperation between the two associations (that have common members) is excellent, especially in terms of sharing data, methodologies, tools and partnerships. ENTSO-E and its members have developed fruitful contacts, sharing experience and knowledge with GO15, too, including two major US system operators.

All in all, power networks stretch across borders and it is crucial that we work with countries like Switzerland or Norway in a very professional way to ensure that the lights are kept on for EU citizens, as well as in countries with which we are linked electrically.

New Scenarios in the Run-up to TYNDP 2020

Initial data has been released on the three scenarios that will be used to develop the 2020 edition of the Ten-Year Network Development Plan (TYNDP) by Entso-E and EntsoG (European Network of Transmission System Operators for Gas). The two associations believe that this data is significant "not only to evaluate future needs in terms of gas and electricity infrastructure, but also to exploit interactions between the two systems." In fact, according to the two companies, sector coupling between gas and electricity will play a key role in the process of decarbonization. Assuming that there the shift from coal to gas will be achieved by 2025, CO2 emissions caused by the production of electricity in the European Union would be reduced by 150 million tons.

The three scenarios are:

Scenario 1 – NT - National Trends: based on the draft national energy and climate plans of the 28 EU member states and EU objectives.

Scenario 2 - GA - Global Ambition
Scenario 3 – DE- Distributed Energy

The three scenarios address all energy outlooks (i.e., they are not limited to gas and electricity), the Paris Agreement objective to limit the rise in global temperatures by 1.5 degrees Celsius, and new EU policies to achieve zero carbon emissions by 2050. However, there is a difference. The GA Scenario privileges centralized generation to exploit economies of scale and the consequent reduction in the cost of emerging technology (such as offshore wind energy), while the DE Scenario is based on a decentralized approach with a focus on prosumers and small-scale plants.

The drafting of the Entso-e and EntsoG TYNDPs will continue in a coordinated fashion over the coming months. The publication of the final documents is expected by the end of 2020 for the Gas TYNDP and spring 2001 for the Electricity TYNDP. The two documents will also be used to select the initiatives that will be included in the fifth list of the Projects of Common Interest (PCI).

3 Decarbonization Scenarios

2030 - Electricity Mix:

60% Renewable Energy Resources
12-18% Gas
4-6% Coal

Final Energy Demand: GA and DE

2030 - 11,000 TWh
2040 - 8,000 TWh

Forecast Generation

Renewable Energy Resources – on the rise

2030 - 60% of the electricity demand in all three scenarios

2040 more than 70% in NT Scenario and dell'80% in the GA and DE Scenarios

Coal - in decline

2025 - 10%

2030 - 4-6%

2040 insignificant percentage

Gas

2025 up to 22% of the electricity mix

2030 - 12-18%

2040 - 9 -12%

Renewable Natural Gas

2030 - 13%

2040 - 54%

CO_2 Emissions – Electricity Sector

2030 - 400 million tons (-75 % compared to 1990)

2040 - 182 million tons (NT), 40 million tons (GA), 46 million tons (DE)

The Role of the TYNDP (Ten-Year Network Development Plan) in the Energy Union

The call for projects, and ENTSO-E's overall remit, is in line with EC Regulation 714/2009 and EU Regulation 347/2013. The legal basis indicates that the TYNDP should help to identify infrastructure projects that are key to achieving the EU's climate and energy objectives. Such projects, known as projects of common interest (PCI) are selected from the TYNDP overall list of transmission and storage projects.

Every two years, the European Commission uses the information in the most recent TYNDP, notably that on individual projects, as part of its process to select and adopt a new biannual list of PCIs. When a TYNDP Project is identified as a PCI it may receive favorable treatment, including accelerated planning and granting of permits. Therefore, PCIs hold a special status amongst TYNDP projects.

Thanks to its unique access to data, stakeholder involvement and analytical capabilities, the TYNDP provides a transparent picture of the European electricity transmission network.

This allows ENTSO-E to support informed decision-making on strategic investments at both the regional and European levels. ENTSO-E also offers unique data sets and sound analyses that can be reused by other risk averse industries.

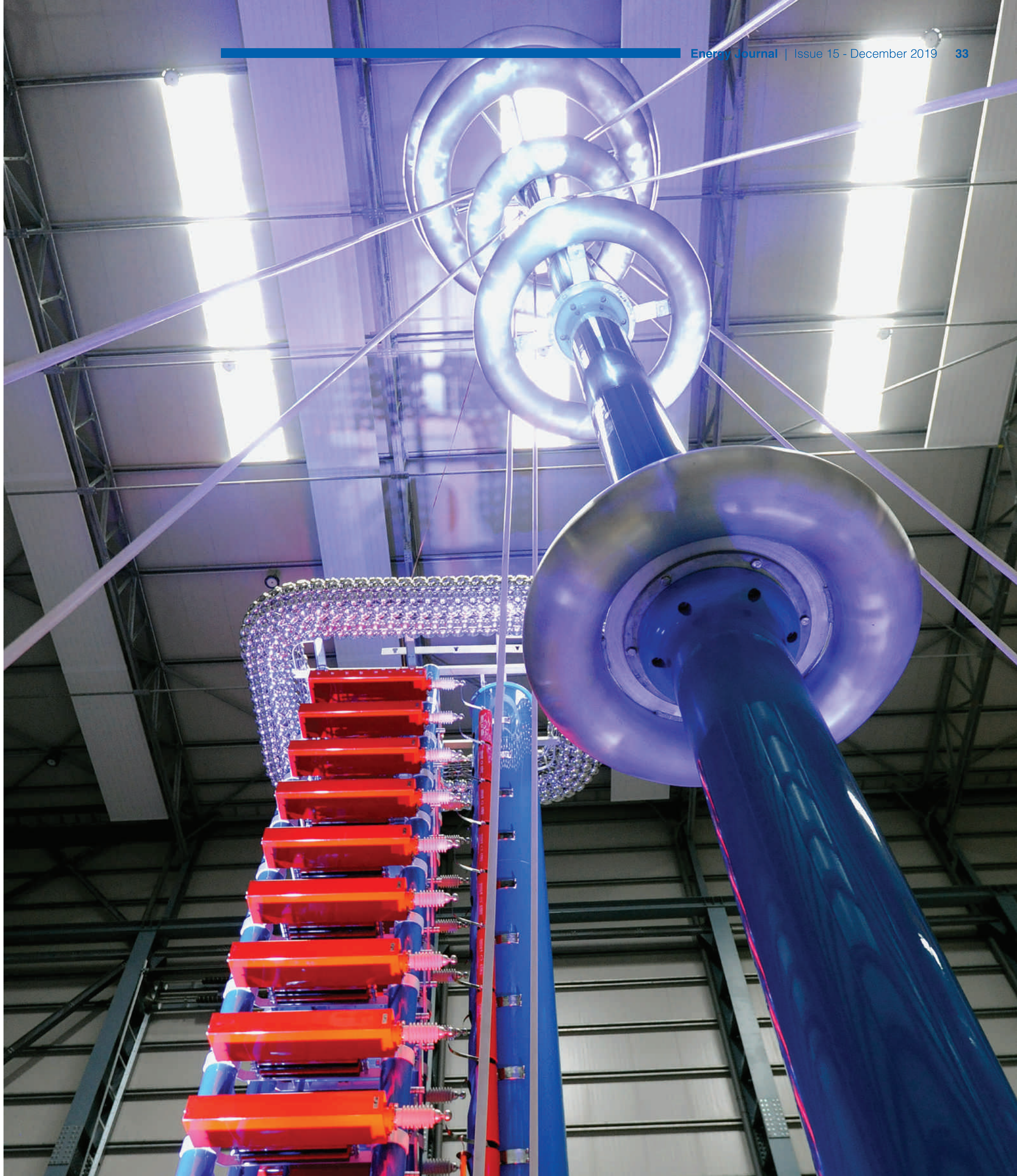
Industries & Countries

KEMA joins CESI: the world leader in testing and certification is born

Thanks to the acquisition of KEMA Laboratories, CESI has become a global leader in testing and certification for the electricity sector.

Today, climate change is a pivotal macro-trend that has profound repercussions on all aspects of our lives. As emphasized by the IPCC, the United Nations Intergovernmental Panel on Climate Change in a 2018 report, the constant increase in temperatures recorded over the last century (+1 degree centigrade) has undergone an alarming acceleration over the past 50 years (+0.2 degrees/decade).

The "Forty-Six Years of Greenland Ice Sheet mass balance from 1972 to 2018" published on Proceedings of the National Academy of Sciences (PNAS) confirms the relentless melting of glaciers (between 1993 and 2016, Greenland lost 281 billion tons of ice a year, while the Antarctic lost about 119 billion), rising sea levels (one meter by the end of the century) and the recurrence



CESI and KEMA Joint Figures

Turnover of more than **€180** million per year

1500 professionals in the network

Project and activities in **40** countries

> Today, climate change is a pivotal macro-trend that has profound repercussions on all aspects of our lives.

of extreme atmospheric phenomena such as hurricanes and storms followed by droughts and heat waves. How can we face the consequences of climate change as predicted by scientists and researchers?

There are two keywords: **mitigation**, implementing all the actions that will slow down the negative climatic trend, and **adaptation** through investments in infrastructure, technology and prevention systems that will protect us from extreme events. This is all taking place with the **energy sector** at the center of a revolutionary transition. It must not only face decarbonization and invest in renewable sources, but also address, manage and resolve energy security issues caused by the effects of climate change.

In this scenario, the need for more reliable and resilient power systems – grids and individual components – is paramount. However, consolidated system design and management paradigms need to be reviewed to achieve an increasing degree of resilience. This means that the role of those guaranteeing the efficiency and reliability of systems through experiments, testing, inspection and certification will become pivotal. And this is exactly what CESI and KEMA have been doing for decades.

The Acquisition of KEMA

CESI's acquisition of KEMA, which was announced in October and will be completed by the end of 2019, includes high-power and high-voltage testing, inspection and certification activities conducted at sites in Arnhem (Netherlands), Prague (Czech Republic) and Chalfont (USA). The acquisition of these sites — in addition to the CESI ones in Milan, Berlin and Mannheim — will allow the two companies to unite forces, competences and assets and become the global leader in the testing and inspections sector.

Together, the two companies will be able to provide services for all the main components of power systems: from low to high and extra-high voltage. In particular, the testing and inspection platforms in Arnhem include the largest high-power lab in the world with short-circuit power loads up to 10,000 MVA, an advanced lab for testing extra-high power components for super grids and the Flex Power Grid Laboratory, an innovative platform for testing power electronics and smart grid components.

The acquisition will allow the Group to access the testing and inspections market in the United States, a country in which it already operates in power consulting through its subsidiary EnerNex. The KEMA Platform in Chalfont, near Philadelphia, is in fact the main independent testing lab in the United States. Moreover, having brought KEMA on board will bolster CESI on the Eastern European market, where it will operate through the ZKU labs in Prague, testing products for clients, major European component constructors with plants in that area of the world. The combination of the expertise and assets of the two companies will allow all sector technology to be experimented and tested, simulating extreme and complex operating conditions. The R&D centers of international component producers will be able to exploit the CESI and KEMA labs to develop and streamline their products right from the research, development and prototyping phases. In addition to power and voltage tests, CESI can, for example, perform tests in controlled climatic environments to test the resistance of components to ice or extremely low or high temperatures.

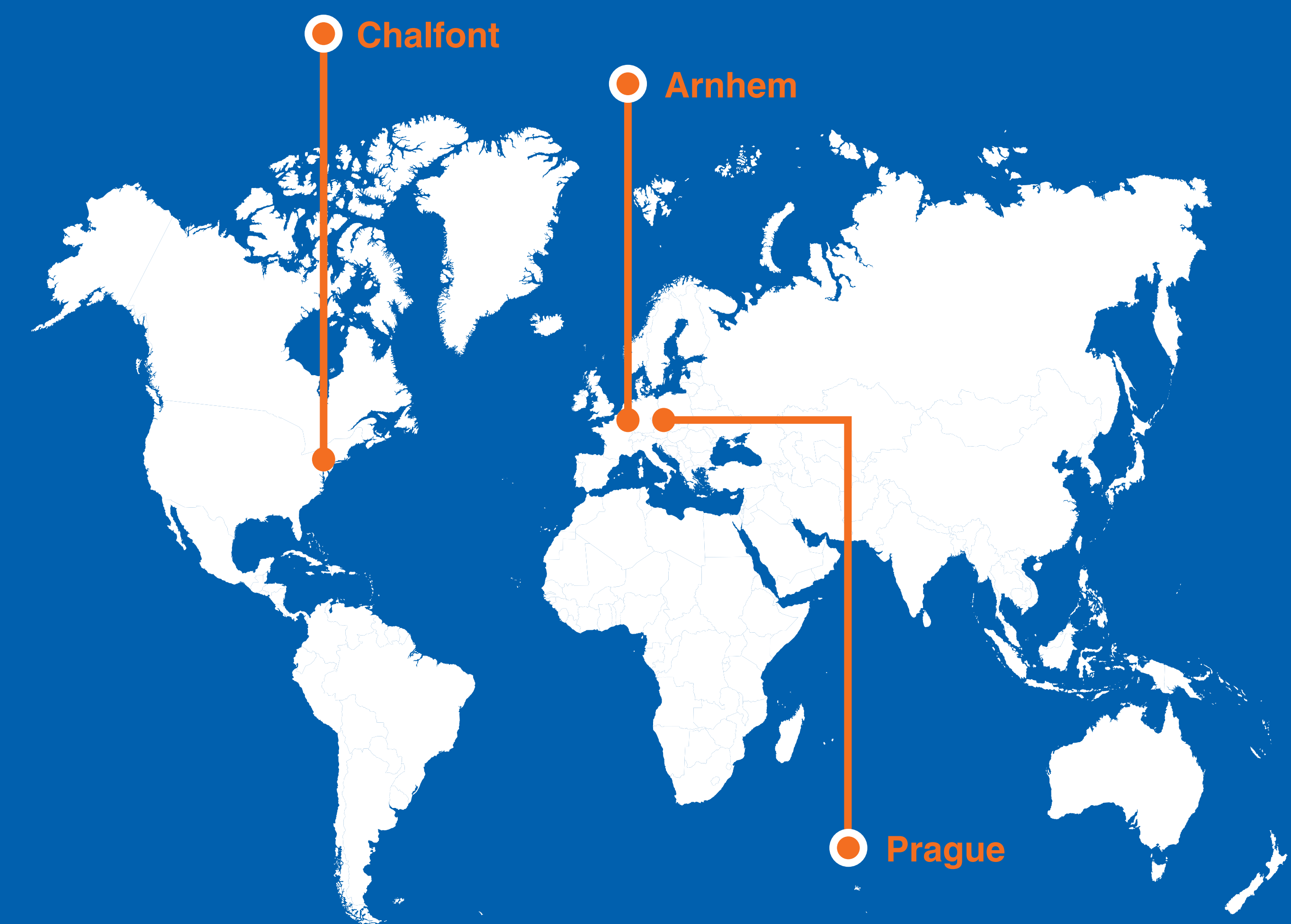
The Group platforms are also used to conduct tests by stimulating the mechanical stress that grid components undergo during heavy downfall, floods and strong winds. Furthermore, the group performs tests on direct current power cables, electric car recharge stations and smart grid and smart meter systems. "Together, CESI and KEMA provide services for all the main components of power systems: from low to high and extra-high voltage. This new approach will allow us to address objectives that efficiently meet our clients' needs by employing our cutting-edge assets and top-quality competences around the world," stated CESI CEO **Matteo Codazzi**.

At this time in history, when duties and trade barriers are in the news, the synergy between CESI and KEMA gives rise to a global company that is present in all latitudes and can deliver for clients in any country. This is a fundamental role in times, such as the current ones, that demand reliable, secure and resilient products and technology to support utilities in providing stable, low-cost and uninterrupted services.

> There are two keywords: mitigation (implementing all the actions that will slow down the negative climatic trend) and adaptation (protecting us from extreme events through investments in infrastructure, technology and prevention systems).

Kema Laboratories

KEMA (Keuring van Elektrotechnische Materialen te Arnhem) NV, founded in 1927, is a global energy testing company seated in Arnhem, the Netherlands. It provides technological testing, inspection and certification services for the electricity secto.



Arnhem

HIGH POWER LABORATORY
The first platform in the world for extra-high voltage tests (1200 kV), with short-circuit power loads up to 10,000 MVA, emitted by four parallel generators.

LABORATORY FOR MEDIUM, HIGH AND EXTRA-HIGH VOLTAGE
Tests with cutting-edge equipment and computerized control systems.

KEMA METERING PROTECTION
Laboratory for testing electricity meters and substation automation.

FLEX POWER GRID (FPG) LABORATORY
This laboratory is dedicated to testing smart grid components at operative voltage and power.

The laboratory allows testing on smart grid components in a high flexible, duplicable and realistic environment. It can replicate grid fault conditions or develop rigorous testing programs to stress equipment well beyond the limits of small-scale grid tests. FPG tests provide an ideal environment to reduce the risks related to advanced technology before it is connected to the grid.

Chalfont, USA

The largest facility of its kind in the United States with 1000 and 2500 MVA short circuit generators, a 1500 kV impulse generator and a 600-kV supply frequency.

Prague

A complete laboratory for testing low and medium-voltage grid components. It has two 2500 MVA generators.

One on One

Europe vs USA: a world of innovation

Both American and European utilities view electrification as a potential strategy to contrast the stagnating or falling demand for electricity. The United States and Europe also share another great challenge: cybersecurity.

For further information on this topic, please contact:

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In October, fires devastated California, revealing once again the challenges necessary to make the local electrical infrastructure more resilient. In 2018, the Pacific Gas and Electric Company admitted that various fires were caused by cables, transformers and electricity posts being knocked down by wind and lighting dry bushes and trees on fire. The company had to schedule a series of planned blackouts to avoid the risk of new fires. The result was that over the course of a few days, two and a half million Californians were left with an intermittent supply of electricity. The PG&E incident is a typical example of the constant investments necessary for electrical network innovation and security. In California, nobody has forgotten about the blackouts and electricity rationing that lasted for nearly a year (June 2000 to May 2001), causing a crisis of wholesale energy prices, significant financial issues for the main distribution utilities and the suspension of the liberalization process. However, the lesson has apparently not been learned. Today, hundreds of millions of dollars in immediate investments are required to stabilize and secure the grid.

The American electrical system is particularly complex. It was developed in a decentralized manner and was then regulated on and off, giving rise to a regulatory patchwork that is hard to understand in comparison to the electrical systems of Europe. In terms of its extension

and the resources required to produce electrical energy, the network has marked local variations. Indeed, many operators prefer to speak about regional networks rather than a single system, also due to the above-mentioned issues with the liberalization process.

Different Approaches, Common Interests

The American electrical energy system includes three networks that are independently synchronized and only weakly interconnected: Eastern Interconnection, Western Interconnection and the Texas Electric Reliability Council (ERCOT), which respectively account for 73%, 19% and 9% of electricity sales in the United States. According to 2018 data from the Energy Information Agency, the aggregate demand for electricity in the United States arises from the needs of ca. 126 million households (38% of the total energy demand), 17.6 million businesses (35%) and 728,000 industrial clients (26%) for a total annual consumption of 3.950 TWh. The European energy system is based on individual

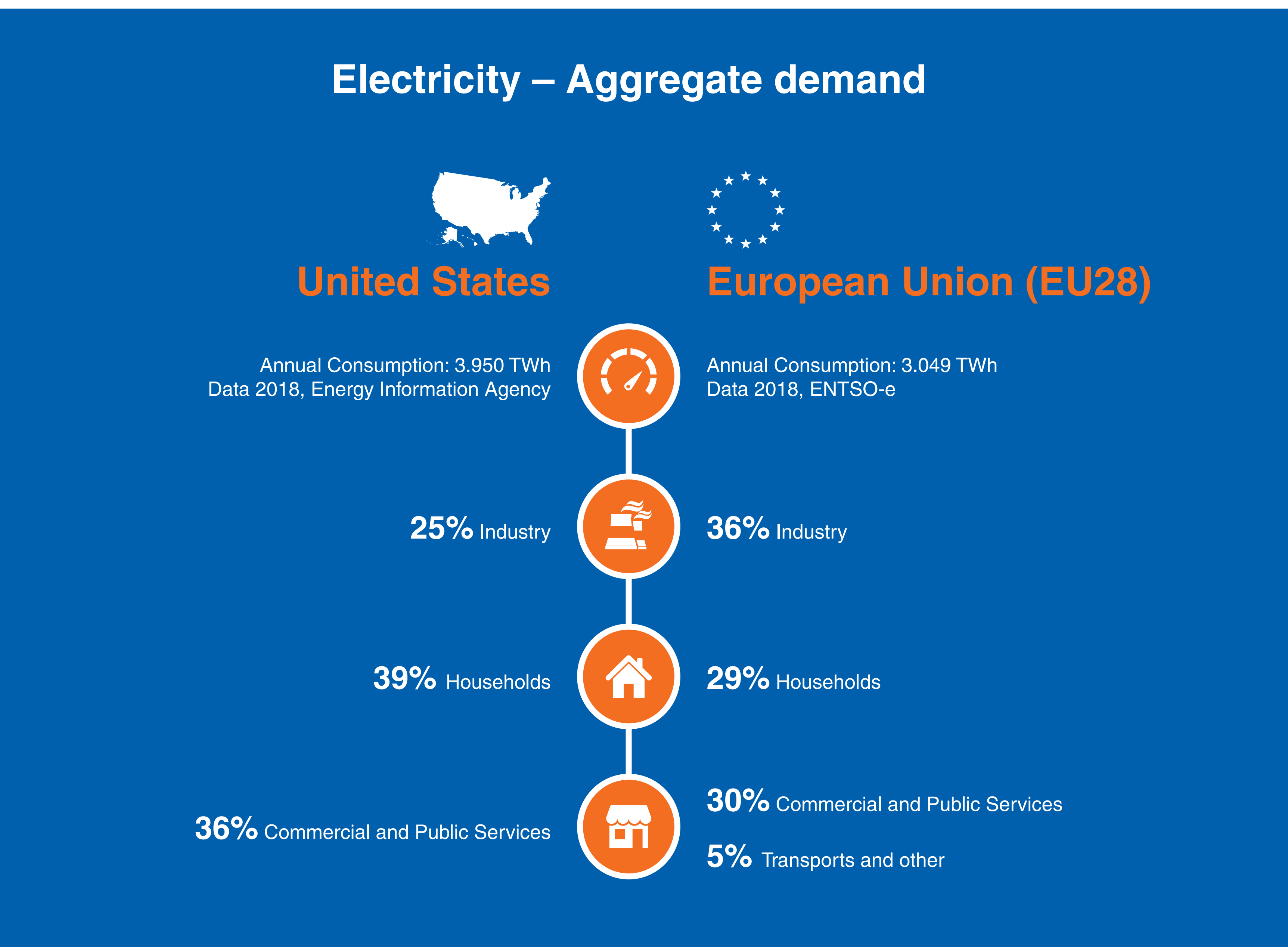
“In drawing a comparison between Europe and the United States, it is evident that the energy sector is undergoing a profound transformation, on both continents, that is being driven by a greater use of renewable resources, new consumer habits and evolving business models.”

member states and their different backgrounds and history. According to ENTSO-e statistics, at the aggregate level, the consumption of electricity in Europe (EU28) reached 3.049 TWh in 2018. Eurostat estimates that electricity consumption is subdivided as follows: 36% (industry), 29% (households), 30% (public services and business) and 5% (transports – mainly railway – and other uses). In drawing a comparison between Europe and the United States, it is evident that the energy sector is undergoing a profound transformation, on both continents, that is being driven by a greater use of renewable resources, new consumer habits and evolving business models. In fact, political and regulatory frameworks must be updated to keep abreast of these changes and facilitate future transformations (often inhomogeneous). In June 2019, the Washington Center for Strategic and International Studies (CSIS) organized a seminar with American and European stakeholders to discuss strategic development, tools for sharing and collaboration opportunities between the two counties. On one hand, the debate addressed the issue of green energy and distributed energy resources. On the other, it concerned the challenges related to electrification strategy – in particular, with regard to measures addressing the electrification of transports and industry – and the growing digitalization of the energy sector (with issues ranging from data access to computer security and network resilience).

In 2016, the European Union and the United States had already started discussing the electrical energy market and the transformation of the sector. In view of the different approaches and common interests of the two sides, the objective is to promote transatlantic cooperation on these issues in line with the constitution of the US-EU Energy Council (the main forum for transatlantic cooperation in the energy sector), which since 2009 provides an opportunity to reflect on the future of the US-EU partnership. As emphasized by the International Energy Agency (IEA) in the World Energy Outlook Report 2018, the penetration of renewable resources will require an increasingly flexible electrical system. In a scenario of sustainable development, by 2040 (with a global temperature increase under 2 degrees Celsius and green energy accounting for 66% of generated electricity), the flexibility of American and European infrastructure will be the result of the interconnected development of smart grids and storage technology, distributed generation and increasingly interconnected networks. Moreover, both American and European utilities view electrification as a potential strategy to contrast the stagnating or falling demand for electricity. In particular, the electrification of the transports sector is considered by sector operators as a further source of distributed energy resources that will make the system even more flexible.

The Cybersecurity Emergency

The United States and Europe also share another great challenge: cybersecurity. The debate between American and European stakeholders has shed light on the issue of resilience, a major political issue on both sides of the Atlantic for transmission and distribution infrastructure. In March 2019, a cyber-attack impacted an undisclosed US electric utility's power grid operations in California, Wyoming and Utah. The event, the first known that has been publicly reported, emphasizes the effective risks that American energy utilities may encounter when their critical control networks are interconnected and exposed to hackers. Since 2018, the American Department of Energy (DoE) has created the Office for Cybersecurity, Energy Security and Emergency Response. The general objectives of the office's multi-annual plan address protocol to prepare for cyber-events: reporting requisites, tools for risk management and resolution of supply chain vulnerability. The Department will implement training programs and drills at the federal level, as well as develop new technology to reinforce network resilience to hacker attacks through incident identification and protection systems. A fundamental step for sharing information is represented by the new standards adopted in 2019 by the Federal Energy Regulatory Commission (FERC) that now requires Regional Coordinators of the North American Electric Reliability Corporation to report any anomalous event concerning cybersecurity. During the summer, FERC President Neil Chatterjee proposed the creation of a task force, in coordination with the National Association of Regulatory Utility Commissioners (NARUC), to solicit states to address network resiliency and security via interaction between state policy and regional electrical energy markets. And what about the "Old Continent"? In the European Union, cybersecurity is controlled by ENISA, the European Union Agency for Cybersecurity. Founded in 2004, the agency focuses on cross-border cyber events that involve more than one member-state. ENISA provides recommendations on cybersecurity and promotes implementation - and collaboration - on cybersecurity policy amongst member states. Moreover, it also manages cyber certificates for products, processes and services.



As part of the Clean Energy for all Europeans Package, the European Union has issued a regulation on risk prevention that requires member states to develop plans for security-related incidents in the electricity sector, both at the national and regional levels. Since 2017, a group of EU experts has been working on the development of an IT Security Code for the electricity sector with the aim of increasing its resilience and protecting infrastructure. At the beginning of 2019, the EU Commission issued a recommendation calling for network operators to renovate powerlines and update their systems with innovative security technology, adhering to international standards and establishing criteria to design resilient architectures. American and European stakeholders have discussed the risks posed by greater connectivity. A fundamental difference between the two countries concerns the issue of access to and ownership of data. While, in Europe, data is owned by the client (and recent legislation provides them with even greater control over their data), in the United States, final user data is the property of utility companies. The debate has shed light on the importance of issues such as data integrity, information responsibility, information protection and non-discriminatory access to information.

The Innovative Drive of Smart Grids

In the United States, techniques to improve the intelligent interaction of distributed resources have been discussed since the 1980s. In fact, it was a call to modernize networks and allow a greater penetration of alternative and renewable energy resources. The first reference to "smart grids" dates back to 2004, when, in an article published on IEEE Power and Energy, University of Minnesota Professor Massoud Amin addressed intelligent networks and the security of critical infrastructure. Although their networks share common characteristics, the United States and Europe have applied different solutions to make their networks smarter. The evolution of American smart grids is related to a number of innovations that have been applied to transmission networks, such as wide-area measurement, rapid checks, the installation of power system stabilizers, phase displacement transformers, flexible alternating current transmission systems (FACTS) and phasor measurement units (PMU). Nonetheless, the modernization of the grid has mostly addressed transmission systems, while the distribution networks have remained largely unmodified. (One of the causes of this situation is the greater variability of the distribution scenario and an economy of scale that is relatively low compared to that of transmission networks.) Notwithstanding the fact that various legislative measures have provided opportunities to modernize the grid, not much has been accomplished and the United States is now looking to overcome critical issues and modernize its distribution networks thanks to the advent of digitalization.

In Europe, the unification of the grid progressed hand in hand with the economic integration of the old continent's countries. It has been a slow process, determined by a range of factors such as the high cost of developing new infrastructure, as well as historical events like the two world wars and the separation of Eastern and Western Europe for over four decades. Indeed, European countries began to organize the interconnection of their networks in 1990 after the fall of the Iron Curtain. However, it wasn't until 2008 that Regional Associations ETSO, ATSOI/UKTSOA (Ireland and Great Britain), NORDEL (Finland, Sweden, Norway and Eastern Denmark), UCTE (23 countries from continental Europe) and BALTSO (Baltic countries) founded the European Network of Transmission System Operators for Electricity (ENTSO-E), which now coordinates 43 TSOs in 34 countries.

> "In 2008, the State of New York created the Smart Grid Consortium, a public-private partnership to promote network renovation and implement smart technology."

Case Studies: New York and Finland

While the United States Federal Government and the European Commission establish general strategic frameworks (and can - to different extents - issue binding and non-binding legislative guidelines), at the local level, it is the European and American states that are responsible for policy implementation (with a certain degree of independence on priorities and innovation). The New York State (United States) and Finland (Europe) are two interesting case studies of proactive organization in this context. In 2008, the State of New York created the Smart Grid Consortium, a public-private partnership to promote network renovation and implement smart technology. The non-profit organization brings together all the main operators collaborating on the energy chain of value, including utilities, market operators, private industry, universities, authorities and final users. In 2011, the organization announced the smart grid implementation policy for the State of New York. What is interesting is that, besides specific activities and initiatives, there was a call to imagine and design the smart grid not as an innovative market product, but as a self-renewing catalyst for the development of new solutions to specific interests and needs. In 2012, building on previous policy, Governor Cuomo called for a taskforce headed by state agencies to develop the New York Energy Highway Project, a concrete action plan to drive further improvement of the state's energy infrastructure. The project includes 13 priority actions in 4 categories: Expand and Strengthen the Energy Highway, Accelerate Construction and Repair, Support Clean Energy and Drive Technology Innovation.

On the other side of the Atlantic, Finland is developing one of the most advanced global smart grid markets and provides an ideal benchmark for tomorrow's intelligent energy solutions. With decades of experience in the management of an extremely stable electrical network and the adoption of smart meters, Finland is concentrating on high-level digitalization and new generation smart grids. Over the course of the years, Finland has not only developed a specific and dedicated smart grid vision, but it has also included its intelligent networks in its global energy and climate policies, as indicated by the strategic guidelines of the European Union. The Finnish Government considers energy policy objectives complementary to national economic growth and elements that provide it with a competitive advantage over its main contenders. This means that special attention is paid to guaranteeing an uninterrupted energy supply with secure, long-term procurement efforts, job opportunities in the energy sector and the exportation of sector technology. In terms of smart grid development and implementation, Finnish distribution operators (DSOs) make independent decisions. The regulatory authority only intervenes indirectly to define rules and criteria for the investments to budget. This means that operators cannot invest unlimitedly in smart grids (or any other related area) as the regulatory authorities establish the limits. In order to implement the smart grid innovation roadmap, the energy industry had already started collaborating with universities in 2008 on research programs financed equally by enterprise and academia. One of the most important of these projects is "Smart Grids and Energy Markets" (SGEM), which was launched in 2009 as a five-year research program with an initial funding of €36 million and the participation of six energy companies, six technology providers, seven ICT and telecommunications companies and eight research agencies.

Investments and Collaborations

In the United States, the electricity distribution segment represents ca. 35% of the overall cost of the energy system. Since 2000, investments in the American distribution System have totaled over US$400 billion (source: EEI 2017) and will attract further investments for US$600 billion in transmission and distribution networks by 2030. However, in recent years, new technological solutions such as energy storage, distributed solar energy and energy efficiency have become cheaper. These eco-compatible solutions can now be implemented independently, allowing utilities to postpone or abandon traditional network investments. For example, Washington State has implemented "non-wire" alternatives to the transmission system. It decided not to build an 80-mile 500-KV power line, turning to alternative grid management and energy storage technology, instead.

New York State is currently developing 36 "non-wire" projects that are in various stages of development, including one in Brooklyn and one in Queens that overall will save taxpayers US$1 billion. In Europe, according to the estimate published by IEA/OECD in its World Energy Investment Outlook (2014), US$650 billion will be necessary between 2014 and 2035 to renovate and extend the electrical networks of EU member states. The roadmap for the EU 2050 Energy Strategy also lists the individual investments required for the grid's transmission and distribution networks. Indeed, over 75% of future investments will target distribution infrastructure. The most probable and feasible scenarios reveal similar investment patterns from 2012 to 2050, with a 40-50% increase over previously estimated investments for 2011-2020. The Ten-Year Network Development Plan (TYNDP) developed by ENTSO-e includes an estimate

Cybersecurity

United States

The US Department of Energy (DoE) Office for Cybersecurity, Energy Security and Emergency Response.

European Union

The European Union Agency for Cybersecurity (ENISA) focuses on cross-border cyber events that involve more than one member-state

Smart grids

United States

In the United States, the modernization of the electrical grid has mostly been limited to transmission systems. Distribution networks have remained largely untouched. Today, the United States is seeking to overcome these critical issues through digitalization and adapt distribution to new trends.

European Union

In 2008, Regional Associations ETSO, ATSOI/UKTSOA (Ireland and Great Britain), NORDEL (Finland, Sweden, Norway and Eastern Denmark), UCTE (23 countries from continental Europe) and BALTSO (Baltic countries) founded the European Network of Transmission System Operators for Electricity (ENTSO-E), which now consists of 43 TSO operators from 34 countries.

Investments

United States

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European Union

In Europe, US$650 billion will be necessary between 2014 and 2035 to renovate and extend the electrical networks of EU member states. The EU 2050 Energy Strategy calls for 75% of future investments to address distribution infrastructure.

of the investment budget per member state, as well as for national and supranational projects of pan-European significance. The total investment budget in the TYNDP 2012 was €104 billion (including €23 billion in submarine cables). The TYNDP 2014 increased the budget to €150 billion by 2030 (same estimate as in 2016, with 2000 energy transmission and storage projects). The takeaway from this scenario comparison is that the growth of distributed generation and the increase in renewable resources can help both the United States and the European Union to become more flexible and work towards achieving climactic objectives. At the same time, these trends present challenges to network operators who are currently trying to develop new strategies to maintain network stability and reliability in a rapidly changing panorama.

The European Union has indicated a global roadmap in the "Clean Energy for all Europeans" Package, reviewing legislation and markets to simplify the integration of renewable energy resources, the flexibility of the electrical system and promoting an electricity market that reaches beyond national borders. The Federal Government of the United States does not currently have a global strategy for the "networks of the future," but various states have been extremely active and are tracing a future system framework with dynamic policies and research on the future of the energy sector. Notwithstanding their different approaches, both the United States and Europe face similar issues with regard to the future of electric energy. In Europe – where electricity represents a basic service and pan-European competition is open, as with any other product or service – there is an integrated decarbonization strategy with an efficient, secure and interconnected internal energy market. Each member state contributes to the achievement of shared objectives, albeit starting from very different conditions.

In the United States – where the dominant opinion is that electric energy is a public service and the role of politicians, legislators and regulators is to protect consumer rights from the power of an excessively monopolistic market – there is no unified outlook; markets are interconnected at either the regional or federal levels. With a view to promoting transatlantic collaboration and innovative research methods (not only in technology, but also in the regulatory domain), there is an ongoing debate between American regional networks and the EU authorities on the exchange of information and on how to improve market interconnection. Sharing good practices is nothing new but speaking about electric networks without reinforcing human networks would be a terrible paradox, and a recipe for economic, cultural and technological impoverishment.

News & Events

Upcoming Energy Events

Ieee Pesgre 2020

January 2 - 4, 2020

Cochin, Kerala, India

http://pesgre2020.org/

The International IEEE PESGRE 2020 Conference on "Power Electronics, Smart Grid and Renewable Energy" is a new biennial event. The first edition of the conference will assess technology, strategy and challenges related to power electronics systems, electric drives and renewable energy resources, address smart grid interconnection and operation, and define an environment-friendly energy production system.

Icfee Conference

January 7 - 9, 2020

Kyoto, Japan

http://www.icfee.org/

The International Conference on Future Environment and Energy will present innovative projects marking significant developments in the energy and environment sectors. The tenth edition of the conference will provide a precious networking opportunity between researchers and professionals interested in the development of environment-friendly technology for the energy sector.

World Future Energy Summit

January 13 - 16, 2020

Abu Dhabi, Arab Emirates

https://www.worldfutureenergysummit.com

The World Future Energy Summit is shaping up to be the main global event on the future of energy, renewable technology and sustainability. The summit, which will be held during the Abu Dhabi Sustainability Week, brings together world leaders and top managers. The showcase area will present pioneering technology related to energy, energetic sufficiency, water, solar power, waste and smart city by 800 specialized exhibitors, attracting 33,500 visitors from 170 countries.

Future Energy Asia Exhibition & Conference

February 12 - 14, 2020

Bangkok, Thailand

https://www.futureenergyasia.com/

The 20th edition of the Future Energy Asia Exhibition & Conference will present a hybrid business platform bringing together Asia's gas, LNG, oil & energy industry to identify solutions and strategies that foster a secure, affordable and low-carbon energy mix for the continent. The conference, which will be attended by Asian leaders, is set to attract over 6000 professionals and 150 industry-leading companies.

F&R Energy 2020 - Fourth International Conference On Fossil And Renewable Energy

February 17 - 19, 2020

Houston, USA

https://energy-conferences.com/about-energy-2020

Previously known as "Gas, Oil & Petroleum Engineering" (GOPE), the fourth International Conference on Fossil and Renewable Energy will address global energy issues. As a forum, it will bring together enterprises and the world of academia to share the most recent technological developments in the energy sector. The program includes experts, academics and top managers who will address trends and strategies to improve energy production, along with high-level information sessions, interactive panels and networking events.

European Energy Efficiency Conference 2020

March 4 - 6, 2020

Wels, Austria

http://www.wsed.at/en/programme/european-energy-efficiency-conference.html

The transition towards clean energy is undergoing new developments in Europe and worldwide. The objective of energetic efficiency calls for strong policy, competitive enterprises, technological innovation, investments and the active participation of citizens. The conference will address these aspects through a series of sessions on energy efficiency policy (domestic and international) and smart electric mobility. The program also includes technical visits to innovative projects and a major fair on construction efficiency and renewable energy with 1600 exhibiting companies that will attract over 100,000 visitors. visitors from 170 countries.

Shaping a Better Energy Future

CESI is a world-leading technical consulting and engineering company in the field of technology and innovation for the electric power sector. With a legacy of more than 60 years of experience, CESI operates in 40 countries around the world and supports its global clients in meeting the energy transition challenges. CESI also provides testing and certification services to the power equipment industry, as well as civil and environmental engineering services.

The company's key global clients include major utilities, Transmission System Operators (TSOs), Distribution System Operators (DSOs), power generation companies (GenCos), system integrators, financial investors and global electromechanical and electronic manufacturers, as well as governments and regulatory authorities. In addition, CESI works in close cooperation with international financial institutions such as, among others, the World Bank Group, the European Bank for Reconstruction and Development, the European Investment Bank, the Inter-American Development Bank, the Asian Development Bank.

CESI is a fully independent joint-stock company headquartered in Milan and with facilities in Arnhem, Berlin, Prague, Mannheim, Dubai, Rio de Janeiro, Santiago de Chile and Knoxville (USA).

www.cesi.it