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Energy Journal

Energy innovation: the digital transformation

Inspired with innovation CESI

Energy Journal
CESI's house organ
Editorial coordination
Paolo Chighine / CESI
Luana Facciolo / CESI
Davide Cospito / CESI

Project, design and translations
Cultur-e
www.cultur-e.it

CESI
Inspired with innovation

via Rubattino, 54
I-20134 Milano – Italia
info@cesi.It
www.cesi.It

«Inspired by the digital evolution underway – explains Paolo Chighine, Executive Vice President for Group External Relations at CESI – we have decided to modify the graphic layout of our cover with the help of artificial intelligence. We have moved from our previous covers based on illustration to photographic covers, developed with AI, to better represent the focus of each issue. Thus, AI becomes an element that unites the evolution of the energy sector and the renewed identity of our magazine, a revolution that is also mirrored in the new lettering of the Energy Journal logo».

Editorial

Digital Innovation as a Catalyst for Energy Systems

Guido Bortoni
Chairman, CESI

Domenico Villani
CEO, CESI

In an era marked by geopolitical turmoil and urgent climate challenges, digital innovation has emerged as a key tool to guide the transition to more intelligent and resilient energy systems. Digitalization is the answer to the growing demand for sustainability and reliability, a map towards the future of energy that is being jointly developed by consumers and suppliers. The energy sector is at a crossroads. It must decide whether to innovate rapidly or remain anchored to outdated paradigms. However, the transition towards a cleaner digital system is not only a choice, but a fundamental necessity in view of recent events and the global drive for decarbonization.

The International Energy Agency, IEA, recently organized the Energy Innovation Forum in Paris, bringing together leaders and politicians from 45 countries. Director General Fatih Birol pointed out that, in order to achieve Net Zero by 2050, it is imperative that we develop innovative technology – technology that is not ready yet – to contribute to the envisaged 35% reduction in emissions. Birol also underlined the importance of presenting demonstration projects by 2030 and the need for governmental action to incentivize investments in the private sector.

Driven by these scenario requirements – Elon Musk recently predicted that a greater-than-human intelligence could emerge by the end of 2025 – this issue of Energy Journal focuses on digital innovation for the energy system, analyzing how recent developments are influencing the global energy panorama. The news and articles in these pages address issues such as the fundamental impact of smart grids in Bangladesh, CESI is contributing to the development of more resilient infrastructure, one of many examples revealing our role in stimulating the production of sustainable energy and promoting regional economic development. Our "Top Story" describes how the integration between artificial intelligence and big data is transforming the energy sector, not simply by making distribution networks more efficient, but also by perfecting demand and supply forecasts. And we will also look at the other aspects: for example, how digitalization on a vast scale implies significant challenges, including the vast energy consumption of the data centers necessary to fuel this revolution. In March, in this context, Europe began to regulate the use of AI with the approval of the AI ACT, a legislative measure that aims to balance innovation with the safeguard of human rights and European values. By establishing international standards for an ethical and responsible use of

AI, the EU seeks to position mankind at the center of technological development, protecting consumers from possible abuse.

In the "Industries & Countries" section, we provide a global analysis of the dynamics of climate change, digital innovation, and energy, highlighting the urgency of efficient solutions to extreme climatic events and infrastructural challenges. The article explores how Europe, the United States, and Asia are adapting, employing interoperability and artificial intelligence to modernize their energy systems. The digital and green twin transition is central to the strategies adopted by these geopolitical blocks; indeed, the digital revolution must be exploited to drive the ecological transition.

In Italy, the debate is concentrating on business strategies to adopt this double transition, promoting efficiency, circularity, and the sustainable use of resources. A study published in early 2024 by the European House-Ambrosetti revealed how – notwithstanding the fact that Italy lags behind other countries in the adoption of advanced technology – the country is experiencing a rapid expansion of digitalization, with businesses that have embraced digitalization outperforming traditional companies by 64%. And this panorama emphasizes the importance of investing in digital technology to overcome the linear economic model, promoting circular and sustainable ecosystems, an approach that is essential in order to navigate the complexity of the modern energy sector and meet the challenges posed by climate change.

Continuing to explore the issue of innovation, the "Future & Technology" section also tackles the **Space Economy**, a sector that enjoyed global investments for ca. €50 billion over 2015-22. Innovative technology such as solar cells are at the heart of this expansion, and they play a fundamental role in shaping the future of space exploration and exploitation. CESI develops, produces, and tests these solar cells; to date, our group has produced solar cells that power over 100 civil satellites for clients in more than 25 different countries.

Energy Journal also provides the "Opinions" of institutional and business leaders on issues related to digital innovation. Amongst these, Paris Mayor **Anne Hidalgo** has used artificial intelligence to manage energy and turn the French capital into a smart city. **Elon Musk**, the founder of SpaceX and Tesla, reflects on the energy consumption that is necessary to drive artificial intelligence. And **Darryl Willis**, Microsoft Vice President, firmly believes that AI and machine learning must be used to improve the security of energy networks and prevent cyberthreats.

It is in this dynamic scenario that CESI's commitment to digitalization emerges both in the energy sector and in the space economy. CESI's contribution is particularly significant for the production and testing of space solar cells, designed to transform solar energy into electricity under the harsh environmental conditions of space. These cells, which are resistant to extreme radiation and temperatures, are essential to provide energy to satellites and other space vehicles, guaranteeing a constant and reliable power supply. CESI is expanding its production capacity to equip more than 8 satellites per month for international clients – an experience consolidated by interplanetary missions – CESI is recognized for its competence in this field. Our objective is to expand the limits of space solar technology and contribute to the advancement of European space programs.

The course has been set. The need to adapt rapidly is evident. Thanks to the digital innovation of energy systems, we are ready to face the future, accelerating safely towards an energy transition that is – more than ever before – an essential priority.

Enjoy the reading!

Guido Bortoni
Chairman, CESI

Domenico Villani
CEO, CESI

Passing the Torch: A Farewell from the CEO

Dear Readers,

As I conclude my tenure as CEO of CESI, I want to take a moment to connect personally with you, our esteemed readers. Over the years, Energy Journal has been a platform for sharing insights, innovations, and the latest developments in the energy sector. Your engagement and interest have been invaluable, and I deeply appreciate your support.

Leading CESI has been a rewarding journey, and I am proud of the strides we have made in advancing energy solutions and sustainability. Energy Journal has played an important role in highlighting these achievements, fostering dialogue, and keeping you informed about the dynamic changes in our industry. I am confident that CESI will continue to thrive and innovate, building on the strong foundation we have established.

Thank you for being a part of the Energy Journal community. Your readership has been a source of inspiration and motivation. I look forward to remaining connected with you and witnessing the ongoing progress and innovation in the energy sector.

Warm regards,
Domenico Villani

Issue 28 / May 2024

Contents

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"Artificial Intelligence is the new electricity."

***Andrew Ng**, American computer scientist, Professor at Stanford, he brought artificial intelligence to China*

News

Latest from CESI

Agreements

Smart Grid in Bangladesh

The modernization of the electric energy distribution network in Bangladesh has taken a significant step forward thanks to this new agreement. The Bangladesh Power Development Board (BPDB) aims to transform infrastructure in four key areas for the country: Chattogram, Mymensingh, Sylhet, and Cumilla. The objective is ambitious: to develop a smart grid that will increase network resilience and efficiency. This will allow a reduction in energy interruption and loss, an increase in automation and management, and improved electric system security.

The agreement was recently undersigned at BPDB at the presence of prominent figures including Nasrul Hamid, Minister for Power, Energy, & Resources, and Antonio Alessandro, Italian Ambassador to Bangladesh. Francesco Comito, CESI Area Manager for South Asia and the Far East, signed the agreement on behalf of CESI. This initiative not only strengthens the bilateral relationship between Italy and Bangladesh, but also confirms the growing presence of CESI in the country, with two new projects that are currently in completion.

“Bolstering overall system security.”

Reconstruction

A Challenge: The Al Faw Port in Iraq

CESI is participating in the project for the development of the Al Faw Grand Port in Iraq on the estuary of the Shatt-al-Arab River. The vast complex will include an industrial zone, a new city, wind farms, and integrated transportation networks. Managed by GCPI with Technital and Daewoo E&C, the first project phase will dredge and reclaim the area to erect a container terminal and an innovative highway, the first submarine vehicle tunnel in the Middle East, to connect the port with the City of Umm-Qasr. Given the substantial challenges – reclaiming mined areas, logistic complexities, unfavorable soil conditions, and material supply issues – the CESI Lab in Piacenza will play a key role in ensuring that the highest standards are respected during this critical project phase, guaranteeing the overall quality of the operation.

“The initiative will have to face significant challenges.”

Interconnection

More Electricity for South Sudan

Juba, the capital of South Sudan, recently hosted a key workshop for the Uganda-South Sudan 400 kV electric interconnection project. This initiative aims to foster the sharing of energy resources and has the ambitious goal of significantly increasing electricity access in a region where less than 7% of the population currently has access to electricity. Supported by the World Bank and the African Development Bank, the project aims to facilitate access to energy and strengthen regional integration in the Nile basin. The project is scheduled to be completed by 2035. Simone Pasquini, CESI Area Manager Africa, is coordinating the consultancy group for this fundamental project. The workshop involved over 50 stakeholders, with a strong presence of South Sudan government authorities, including Ministers Pal Mai Deng and Simon Mijok Majak, as well as Lothar Jaschke, Deputy Head of the EU Delegation to South Sudan.

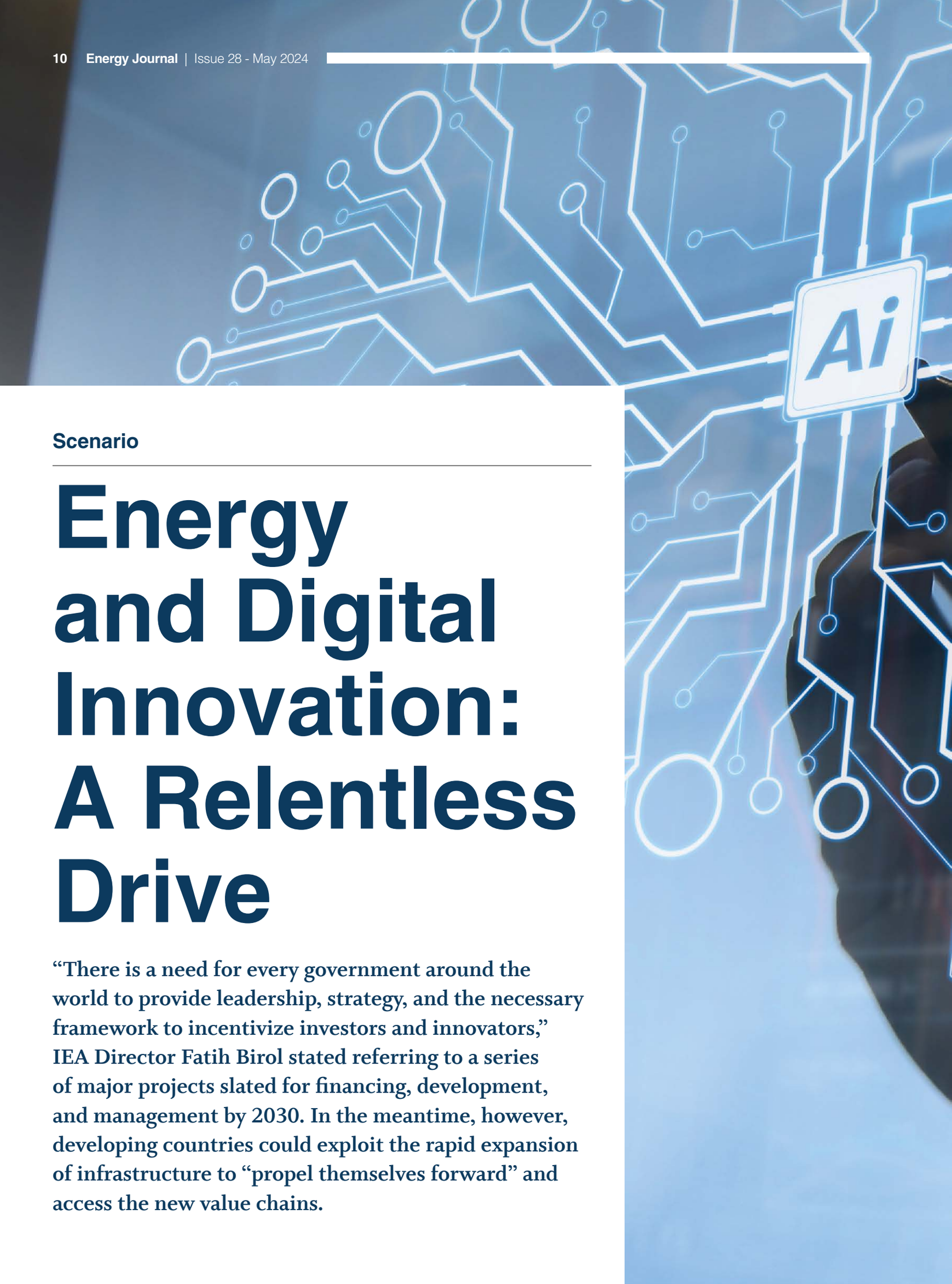
“Less than 7% of the population has access to electricity.”

Space Economy

CESI to supply Solar Cells to SpaceTech

CESI has signed a contract with German company SpaceTech GmbH, one of the leading global companies in the production of space systems, for the supply of hundreds of thousands of solar cells to equip eight satellites per month for five years, with options exceeding a total value of €100 million. The solar cells will serve to power American satellites, facilitating global internet connectivity, including coverage of the north and south poles. “The contract signed with SpaceTech is not just a reflection of our technological competence, but also of our ability to be a key part of ambitious projects. Space technology will increasingly support terrestrial applications, thus contributing to improving life on our planet,” explains CESI CEO Domenico Villani. The Italian multinational is one of the only four companies producing this type of solar cells worldwide, and the only one that is completely European owned. Besides the contract with SpaceTech, last summer CESI and ASI (Italian Space Agency) signed a €13 million contract as part of the “Space Factory” Project to expand CESI’s production capabilities.

“Improving life on our planet.”



Scenario

Energy and Digital Innovation: A Relentless Drive

"There is a need for every government around the world to provide leadership, strategy, and the necessary framework to incentivize investors and innovators," IEA Director Fatih Birol stated referring to a series of major projects slated for financing, development, and management by 2030. In the meantime, however, developing countries could exploit the rapid expansion of infrastructure to "propel themselves forward" and access the new value chains.

For the last half century, the energy sector has been affected by various inevitable global transformations. The current decade is characterized by the evolution of green technology, such as photovoltaic and electric vehicles, which is driving progress relentlessly towards a more sustainable future. However, despite the availability of new forms of technology, **the drive for innovation in the field of clean energy remains fundamental and requires increasingly urgent action**. To fund basic research and development, the governments of individual countries are committed to providing specific support to innovative projects, simplifying cooperation between research and industry. Moreover, international institutions must enable favorable conditions for the expansion of new markets, encourage healthy competition, reduce investment risks, and stimulate innovation.

To tackle this challenge, in February 2024, the International Energy Agency (IEA) organized its **Energy Innovation Forum**, bringing together approximately 250 entrepreneurs, business leaders, investors, and policy makers from 45 countries.

For further information on this topic, please contact:

Alessandro Bertani (Services & Smart Technologies Director)
alessandro.bertani@kema.com

At the Forum, which inaugurated the IEA Ministerial Meeting of 2024 in Paris, coinciding with the Agency's 50th anniversary, Executive Director **Fatih Birol** explained that "in the IEA net zero by 2050 scenario, 35% of the reduction in emissions were to be accounted for by low-emission technology that is still not available on the market. By 2030, a series of major exemplary projects will have to be financed, developed, and managed, to become a top-tier sustainable investment worldwide." Birol also added that "every government around the world must sit in the driving seat of innovation, providing leadership, strategy and also the necessary framework for the private sector and other investors and innovators to be incentivized."

While energy innovation policy and enterprise support measures are evolving rapidly around the world, the **most recent IEA data on global venture capital funding** (VC) for energy start-ups presents a sobering reality. Despite we are well above the levels of 2020, venture capital investments in this sector decreased by 23% in 2023, dropping to just over US$35 billion.

The technological priorities that emerged from the Parisian forum highlighted large-scale industrial processes for which the commercialization of available low-emission technology remains a fundamental challenge in key sectors: iron, steel, and cement production. Moreover, participants underscored the potential contribution of new digital products, including **artificial intelligence for energy networks** and batteries that require less critical minerals. A session dedicated to industrial decarbonization showcased recent in terms of electrification options for high-temperature heating requirements. There is significant potential for collaboration

in this sector amongst countries, industrial sectors, and even competitors at different business stages. However, large-scale investments are heavily dependent on available infrastructure, competitive electricity prices, and access to low-emission hydrogen.

Further issues that garnered significant support during the many sessions include the importance of innovation in **clean energy for emerging economies**, with an emphasis on access to energy, clean cooking, and the ways in which innovation is transmitted within these countries. While it is true that **technology to produce clean energy could represent a new milestone in industrial development**, driving growth and jobs, in some cases, developing countries could "surge forward" accessing new value chains by exploiting the rapidly expanding infrastructure, the common need for accessible solutions, global digital competences, and excellent renewable energy resources. However, current ambition levels lack the necessary ambition to seize these opportunities and the high cost of capital in developing economies continues to represent an obstacle to investments in innovation.

Networks as Digital Platforms

We know that, in the electric sector, digital technology plays a transversal role, improving not only operational efficiency and reducing production costs, but also enabling new energy ecosystems, creating innovative business models, and accelerating the energy transition. As repeatedly highlighted in the IEA Report on "**Electricity Grids and Secure Energy Transitions**" published at the end of 2023, the capacity of the global electric grid will have to double to satisfy new connection requests by distributed energy resources, including photovoltaic plants, charging stations, storage systems, wind farms, and the constantly increasing number of devices. In such a scenario, bolstered by continuous investment growth, **networks will have to be transformed into inclusive platforms** allowing electricity distributors to be more flexible and become coordinators of an energy system including suppliers, regulatory bodies, electric energy producers, clients, prosumers, and EV charging operators.

Digitalization is transforming electric infrastructure into an increasingly smart network, adding intelligent devices, automation, and control software that operate in a coordinated manner. The objective is to increase resilience, reliability, and security, minimizing operational. While for utilities one of the **main challenges is to maintain operative integrity** – a complex operation because of the distributed energy resources (DER), the increase in power electronics, the frequency of extreme climactic events, and the greater expectations of consumers – the solution requires a complete suite: an energy management system (EMS), often referred to as an **Advanced Distribution Management System** (ADMS), that can guarantee a greater reliability and solidity of electric infrastructure.

Closely related to the issue of smart grids and the intermittency of renewable sources – that are by their very nature subject to variation in availability – is the growth of **energy storage systems capable of stocking large quantities of energy to manage periods of peak demand**, which allow a systematic use of green energy. Energy storage – which is fundamental for decarbonizing the energy system and reducing greenhouse gas emissions – is available in various forms; nonetheless, lithium-ion batteries are currently the preferred technology thanks to their cost-effectiveness and high efficiency. **Battery Energy Storage Systems**, which allow energy to be stored from various sources and used as necessary, will be the focus of an upcoming issue of Energy Journal. In fact, we will see how these systems – assembled from one or more batteries – are used to balance the grid, guaranteeing energy reserves, and improving stability.

The Potential of Digital Twins

Digital Twins are a transversal tool introduced by digital transformation that allow the creation of detailed virtual copies of physical objects, resources, and systems, increasing productivity, simplifying operations, and driving profits. They are not futuristic projects, but concrete applications that are widely used in various industrial sectors that still hold unexplored potential.

The "**Digital Twins for the Twin Transitions**" Study (produced in 2023 by Atos Italia and The European House Ambrosetti) addressed the impact of digital twins for the Italian economic and social scenarios. This technology, which allows the creation of interactive and predictive objects and complex systems, holds a great promise and value for industry. According to the study, a systematic use of digital twins in various sectors and technological applications could boost the Italian GDP by €12 billion (+0.7%), also thanks to increased productivity in the manufacturing sector (+4.5%), a reduction of greenhouse emissions totaling 30 million tons of CO_2 (-7.3% in Italy compared to 2021, or 23% of the total emissions that Italy must eliminate by 2030), and a reduction of national utility bill costs (16-33%).

Energy Data and Algorithms

In this panorama, **Generative AI** emerges as a potent tool to improve the efficiency, resilience, and security of energy transmission and distribution systems. Generative AI can be used to analyze and predict energy consumption models, optimize energy distribution based on demand, predict failures and anomalies in the electric system, and create simulation models to improve operative planning. **In a smart grid, these algorithms can be used to analyze data on user energy consumption** and generate predictive models capable of pointing to peak demands in given periods. Thanks to the combination of digitalization and artificial intelligence, it will be possible to develop custom-tailored solutions for electric market clients and drive a more informed and sustainable consumption of energy.

While we address artificial intelligence in our Top Story (p. 28), AI will contribute to the **development of solutions for the integration of renewable sources in networks**, a crucial aspect of decarbonizing the electric sector. The enormous quantity of data

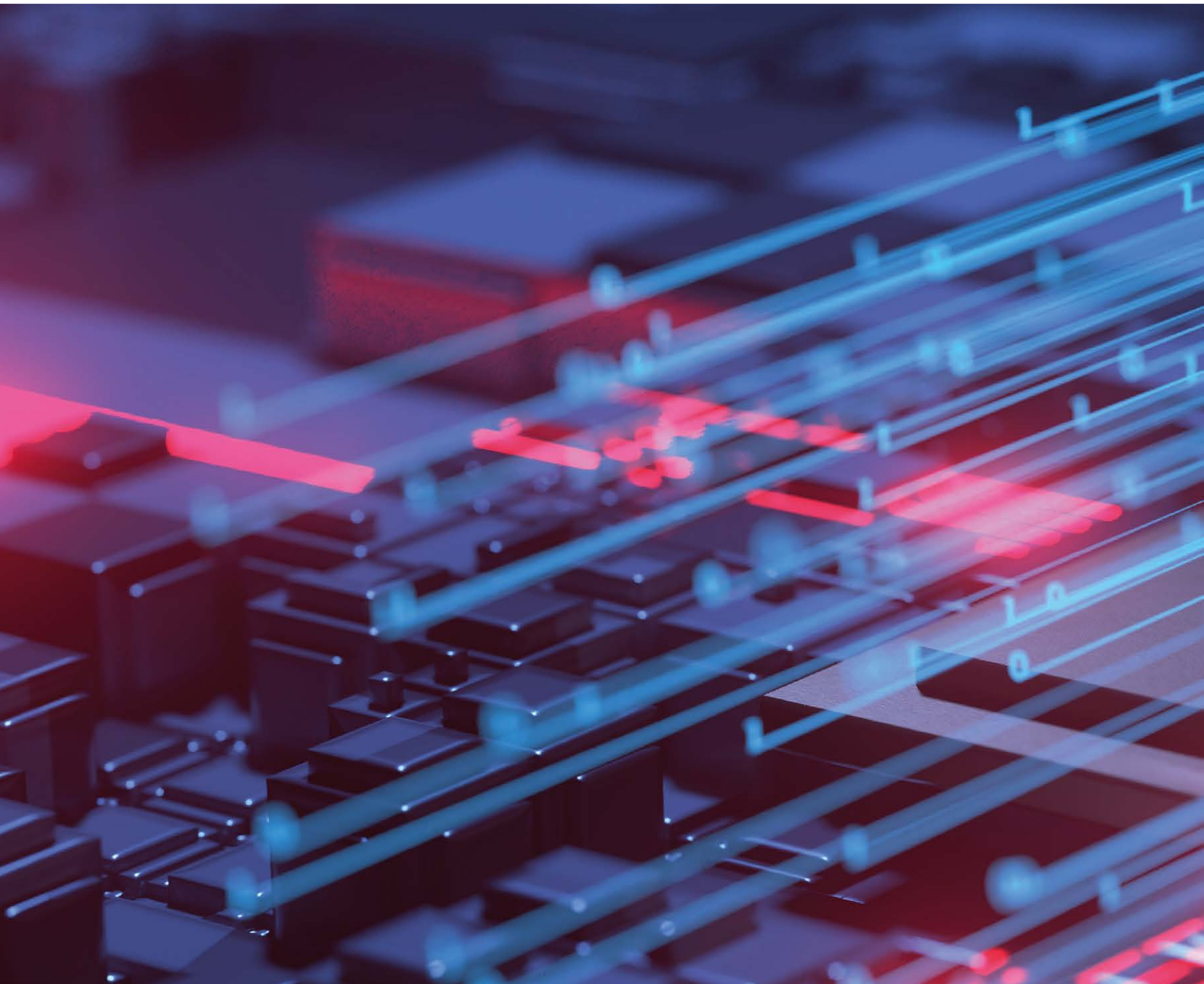
generated by electric systems require tools that can select, analyze, and transform it into decisions. In this sense, the application of artificial intelligence and machine learning techniques are driving new business applications and models throughout the energy system.

At the same time, artificial intelligence, data centers, and cryptocurrencies are contributing to a growing share of electric consumption. According to IEA's recent "**Electricity 2024**" Report, the energy consumed by data centers, artificial intelligence, and the cryptocurrency sector is projected to double by 2026. Data centers are driving the increase in demand for electricity in many regions. In fact, they accounted for the global consumption of approximately 460 terawatt hours (TWh) in 2022 and are expected to exceed 1000 TWh in 2026. **This demand is equivalent to the electricity consumed by a country like Japan**. Updated legislation and technological improvements, also in terms of efficiency, will be crucial to manage and control the increase in energy consumption.

A Greater Need for Cybersecurity

Along with its many benefits, **digitalization also heightens security risks**. Indeed, full digitalization can make electric systems vulnerable to cyberattacks and the energy sector is facing unprecedented threats. From 2020 to 2022, the number of weekly attacks on energy companies doubled. Notwithstanding the fact that not all attacks were declared – and some were not even identified – the IEA has highlighted the significant increase in cyberattacks that, in 2022, rose from 499 to 1101 per week. **Besides leading to decreased energy supplies, cyberattacks may also compromise the personal data of clients**. In this panorama, utilities are investing, on average, 8% of their IT budget in cybersecurity, but this is insufficient to keep abreast of the increased threats. One critical issue is the lack of qualified professionals in cybersecurity. Globally, there are 3.4 million vacant job posts in the sector.

The "**Cyber Resilience of Critical Energy Infrastructure**" Study (published in October 2023 by the United Nations Economic Commission for Europe Group of Experts on Energy Efficiency) emphasizes that, as the energy system is a critical infrastructure and energy the backbone of society, the consequences of cyberattacks could be devastating and have economic, social, and environmental



repercussions. Recent ransomware cyberattacks (malware that demands a ransom to remove system limitations) on critical infrastructure that have led to temporary blocks and the loss of data are also on the rise. **Ransomware attacks nearly doubled in 2022** and increased by 35% in the last six months of 2023. Moreover, there also was a 53% increase in malware attacks (programs that attempt to alter the normal operation of a device) on industrial infrastructure.

The **World Economic Forum**'s Cybersecurity Center advocates for collaboration between industry, academia, and civil society to identify shared solutions to these threats and increase the cyber-resilience of global electric infrastructure. The Forum recommends that every utility, no matter its size, **should consider cybersecurity a central element of its business strategy**, guaranteeing access to internal professionals and constantly updating their competences. In view of the increasing rate of digitalization and the evolving threats, it is essential for energy companies to adopt digital defense strategies as a fundamental part of their operations. Furthermore, it is vital to hire professionals that will be able to face specific (and long-term) cybersecurity threats. Indeed, understanding how to hire and keep the best talent in this field can make all the difference.

Industries & Countries

The Future of Energy: The Challenges and Opportunities of Digital Innovation

The need to improve data management is propelling the United States, China, and the European Union to invest in projects addressing the so-called "Twin Transition." Undoubtedly, a significant digital revolution is essential to allow energy systems to achieve the green transition objectives set for this decade.

Digital technology is progressing more rapidly than any other innovation in the history of mankind. Data dominates how we live, learn, travel, and interact. Similarly, the energy sector has followed suit, benefiting from **the advantages provided by digitalization**, which allows for more dynamic, efficient, reliable, and sustainable activity. Digitized energy systems can exploit flexibility on the demand side to provide electricity at the right moment, to the right place, at a lower cost, and with lower emissions, thus also guaranteeing user satisfaction. Distributed energy resources, such as energy efficiency, smart electric vehicle charging, energy storage in buildings, and distributed solar photovoltaic, are becoming increasingly crucial, year after year.

There is a close connection between digitalization and decarbonization. A report released by the International Energy Agency (IEA) at the end of 2022, entitled "**Advancing Decarbonization through Clean Electricity Procurement**," highlights how the lack of reliable data is one of the greatest challenges to greater decarbonization. Access to quality data is fundamental to support clean energy strategies, quantify progress, and identify associated emission reduction. In addition to promoting the diffusion of the main forms of digital technology, existing data and digital resources also provide advantages to both consumers and the energy system. **In 2019, it was estimated that utilities only exploited 2-4% of collected data.** Within electrical systems, for example, machine learning, smart meters, and other digital technology can aid in integrating greater quantities of variable renewable energy and provide a better matching of supply and demand from increasingly heterogeneous decentralized sources, such as electric vehicles (EV) and other connected devices. In the final user sector, digital technology can improve the efficiency of buildings and transportation, whilst also allowing a shift

to low-carbon emission options. The IEA has estimated that the global management of the demand for electricity could cut the need for new electric infrastructure by US$270 billion. Another study suggests, addressing the period 2020-30, out of a total of €400 billion in distribution network investments, **digitalization will require ca. €170 billion**.

By 2022, the European Climate, Infrastructure, and Environment Executive Agency (CINEA) published "**Digitalization in Urban Energy Systems**," a report focusing on the urban digitalization of energy systems. According to the United Nations, 55% of the global population currently lives in cities and this percentage will increase by 15% by 2050. Cities are responsible for 70% of global CO_2 emissions and 60-80% of global energy consumption. Therefore, they require a stronger commitment and greater ambitions to achieve climatic neutrality objectives. **Digitalization represents an opportunity, as only 10% of the generated data is currently analyzed and applied.** As stated in the "Digital Europe – How to Spend it: A Digital Investment Plan for Europe," **digital technology has the potential to reduce global CO_2 emissions by 20% by 2030**, especially in sectors such as energy, transportation, construction, agriculture, and manufacture.

Some countries have begun investing massively in the digitalization of urban energy system. For example, **Belgium** has promoted 62 projects through two programs providing €400 million each. In **Finland**, 26 projects have been developed since

For further information on this topic, please contact:

Luca Migliorini (Product Leader E-mobility & Hydrogen)
luca.migliorini@cesi.it

Davide Piccagli (Automation & Innovative Solutions Product Leader)
davidestefano.piccagli@cesi.it

2017 for a total budget of €45 million. **France** supports start-ups in the smart city sector with €50 million from a fund dedicated to tomorrow's cities. Similarly, a **German** program has allocated €150 million. In 2016, **Italy** announced an initial budget of €65 million for similar operations. A pilot project for smart cities in **Slovakia** received €1 million funding by the state-funded. In 2017, the **United Kingdom** spent £32 million on its IoT program. Thanks to a program called "Future Cities Demonstrator," Glasgow received £24 billion, while Bristol, London, and Peterborough received £3 million each. In the **United States**, the Smart Cities Initiative has allocated US$165 million to be invested in smart city solutions. Moreover, the initiative added a further US$80 million in investments in 2016.

European Union

The objective to become the first continent with a zero impact on the climate by 2050 and the **2020-30 drive for digital transformation** are two of the European Community's most ambitious priorities for the coming years. The objective of the "twin transition" is to harmonize these two transformative processes – the green and the digital revolutions – seeking solutions that will support economic growth, stimulate employment and innovation, and reduce our environmental footprint, through the utilization of digital technology. The 2020-30 **action plan for the "Digitalization of the European Energy System" ratified by the European Commission** calls for an investment of approximately. €584 billion in the electric grid, especially in distribution networks. A

substantial part of these investments will have to be dedicated to digitalization.

In 2021, the **Digital Europe Program** was ratified with a €7.5 billion budget to develop the EU's strategic digital capacity and drive the deployment of digital technology. It addresses sectors such as advanced computer science, cloud, data and artificial intelligence, cybersecurity, advanced digital skills and how to best accelerate the use of technology. **Managed by HaDEA, the objective is to digitally transform Europe**, promoting competitiveness and strategic independence, and influencing the adoption of new technology based on European needs and values.

Implementing a digital and sustainable transformation of the European energy system will require the installation of solar photovoltaic panels on all commercial and public buildings by 2027, and on all residential buildings by 2029, installing 10 million heat pumps over the next three years, and replacing 30 million old combustion engine vehicles with zero emission vehicles by 2030. In order to achieve these objectives, **Europe will have to develop a far more intelligent and interactive energy system**, investing in digital IoT technology and 5G/6G connectivity, and develop a pan-European energy database driven by cloud services, edge computing, and digital twins. This will facilitate the transition towards clean energy and benefit daily life.

European research

There are five main areas of research in the European scenario. The first, which includes four projects (**Interface**, **Coordinet**, **Sharing Cities**, and **Interconnect**) that were completed between 2022 and 2023, allowed the development of European infrastructure for sharing data for new energy services. The second area addresses the development of tools to participate in the energy market and raise the awareness of citizens. This implies the **development of a data-based energy service market**, founded on consumer

advantages and related rights, as well as the development and implementation of activities to requalify and improve skills and provide "digital energy literacy."

Projects **Drimpac** and **Compile** both concentrate on the role of citizens in a digitalized energy market. The objective of the third research area was to improve the use of digital technology in the energy sector by promoting investments in research and innovation. Project Romeo devised a solution for the structural monitoring of wind turbines based on mega-data, machine learning, and cloud-based analyses, while Project **Edgeflex** developed an advanced energy aggregator for virtual power plants (VPPs).

The fourth area of research targeted cybersecurity in the energy sector to satisfy real-time requests. Project **SerIoT** developed an intelligent solution to allow IoT networks to continue working, independently from network conditions. Project **EnergyShield** developed a toolkit to help protect power system and electric energy managers from sophisticated cyberattacks and data theft. The fifth and final area of research aimed to develop actions promoting climate neutrality in the IT sector. Project **BodenTypeDC** developed a data analysis center to provide innovative and more efficient solutions for reference energy sectors.

In November 2022, the European Commission financed Project **Enershare**, launched by a consortium of international leaders and market drivers in the energy and science sectors, with €8 million. The main objective of the project was to develop and **implement a common European space for energy data and accelerate the digitalization of the electric sector** by updating a series of technological elements, including interoperability, trust, the value of data, and governance.

Italy

In the context of CO_2 emissions reduction, digital technology allows the efficient control of enterprise and energy system operative variables, as well as promoting a greater automation and optimization of resource consumption. The integration of advanced digitalization processes in companies can also simplify the control of greenhouse gas emissions and contribute to the **development of**

digital passports for products. This process, which improves the traceability of materials and components and promotes the circular economy, was addressed by the first "**Digitalization & Decarbonization Report 2023**" published by the Energy & Strategy Group of the School of Management at the Milan Polytechnic in January 2024.

"The PNRR is one of the main levers to finance the development of digitalization in various crucial sectors of the country," commented Federico Frattini, Vice Director of E&S and study coordinator, "thanks to investments totaling ca. €34 million, 53% of which have already been allocated. **Investments in digitalization, especially in the energy sector, are providing encouraging results** and the assignment of calls represent a significant turn and important opportunity to change the technological scenario in Italy."

The **increased installation and use of data centers** deserves particular attention as they are essential to the progress of digitalization. Moreover, such expansion has not caused a proportional increase in energy consumption and CO_2 emissions. In fact, according to IEA data, while the global workload related to data centers increased by 340% in 2022, as compared to 2015, **energy consumption only rose by 20-70%**. This result was achieved thanks to the improvement of IT components and a more efficient energetic management of data center infrastructure, including cooling technology.

While there are significant opportunities for improvement (both in terms of legislation and the integration of digital technology) in the energy production, construction, and transportation sectors, some observers point to a **general inadequacy of current legislation**, which limits the development and application of new technology. In any case, reducing the environmental impact of energy production is a top priority and digital technology, such as **smart networks, remote monitoring, and the integration of predictive maintenance systems**, will play a significant role.

In this context, the national debate is focusing on how to adopt the twin transition for businesses. Which solutions can promote both the green and digital transitions? What technology, processes, and strategies should be adopted to reduce the environmental impact without compromising economic

performance? This issue was addressed in Milan, in January, at the presentation of a study produced by **The European House-Ambrosetti in partnership with Avvale**. "The world of research," explains the Scientific Director of the Italian Technology Institute, Giorgio Metta, "is constantly seeking new forms of technology and sustainable materials; however, without efficient and circular models, scientific progress is helpless. **The green transition is not a technological challenge, it's a systemic challenge.**" And in this context, Metta insisted that "companies can leverage new digital technology that, besides making processes increasingly more efficient, will also create new modes of consumption and interaction between consumers and companies, extending the intensity of use and recycling of products and materials." "Digitalization," adds Domenico Restuccia, Avvale founder and CEO, "provides us with adequate tools to overcome a linear economic model and promote circular ones, in which products and materials are fully exploited for as long as possible, on an industrial scale."

Research highlights that, **in the context of business digitalization, Italy does not fare as well as other countries**. In fact, only 27.8% of Italian companies employ advanced technology (defined as "high" or "very high" quality), 4.6% below the European average and more than 10% less than Dutch and German businesses. However, Italy shows positive signs that it is catching up and improving. Moreover, **between 2017 and 2022, digitalization increased by 75% in Italy**, the highest growth rate in the European Union. Moreover, businesses that have invested in

better digital infrastructure reveal a **64% increase in productivity compared to non-digitalized companies**.

United States

The United States has concentrated on **Grid-enhancing technologies (GET)** that maximize the transmission of electricity with a set of technologies that include sensors, power flow control devices, and analytical tools. GETs include hardware/software systems that dynamically increase the capacity, efficiency, reliability, and security of existing powerlines; moreover, they do so more quickly and at a cheaper cost than traditional network development.

An analysis by the Rocky Mountain Institute (RMI) reveals that the PJM Interconnection, the largest network operator in the United States, could integrate a further 6.6 GW of clean energy into the grid by using Grid-enhancing technologies. The "**GETting Interconnected in PJM**" study reveals that although GETs – including dynamic line rating (DLR), advanced power flow controls (PFC) and topological optimization (TO) – are increasingly studied and implemented, both in the United States and at the international level, they are still not considered routine in planning paradigms for studies on the interconnection of network operators.

Freeing up further capacity for the transmission of clean energy, the 95 GET projects addressed by the RMI analysis **could generate savings for ca. US$ 1 billion on annual production costs**. "With the growing demand for electricity necessary for our lives and the clean energy projects under development, the United States grid needs to expand quickly," states Katie Siegner, an electric sector expert at RMI. The RMI study also indicates that GETs could simplify the interconnection of 6.6 GW of new wind, solar, and stored generation in Illinois, Indiana, Ohio, Pennsylvania, and Virginia that would have otherwise required prohibitively expensive and time-consuming network adaptation costs. Moreover, the evaluation and implementation of GETs as network updates allow a quicker and cheaper integration of large volumes of new generation. Indeed, besides cutting expenses, **GETs significantly reduce the time necessary to connect new generation**. In fact, while the reconduction or reconstruction of powerlines may take as long as three years, or more, according to RMI, transmission network owners can implement GETs in just a few months.

The analysis highlights how the introduction of new optimized generators

for the use of GET technology, together with a potential reduction in network congestion, could lead to a **significant reduction in the cost of energy production**. According to RMI, this would translate into a substantial saving for electricity consumers, with an estimated US$1 billion reduction in costs by 2027, and even more starting in 2030. In parallel, the reduction of operative expenses (OPEX) ensured by the efficiency of new renewable resources and storage systems, along with the **reduction in congestion allowed by GETs**, should promote the integration of further low-cost generation capacity in PJM networks.

China

In January 2024, Jiangsu, in Eastern China, launched the first provincial-level smart electric grid which has **integrated more than one trillion data elements on electric energy**. This innovative virtual electric grid, created in a digital environment, exploits **state-of-the-art technology such as the BeiDou Satellite Navigation System and artificial intelligence**. The system, which is composed of a wide array of sensors and controllers, dynamically monitors the state of the electric grid over an area of 100,000 square kilometers. Thanks to its ability to provide real-time data on the operative state of the network, this digital initiative promises to **significantly increase the efficiency of the energy system**, allowing an accurate monitoring of the production of wind and solar energy, as well as of charging stations and energy storage systems.

In response to trends and conditions related to the installed capacity of renewable energy, **the smart gird can automatically calculate the course of optimal development, reducing planning time by 60%**, and allowing a more rapid connection of green energy to the grid. The digital system also identifies power interruption points by analyzing minimal anomalies in energy consumption data and automatically initiates remote solutions via **intelligent maintenance programs, accelerating the return of power to specific areas**. As a key pilot project for the development of a new energy system, the smart digital infrastructure in Jiangsu aims to extend its interaction with other systems to provide innovative solutions for smart cities.

China is committed to extending the digitalization of the energy system with investments in digital technology in order to improve efficiency, reduce costs and emissions, and promote the use of renewable energy. In its "**China Power System Transformation**" Report, IEA explains how China aims to reduce both

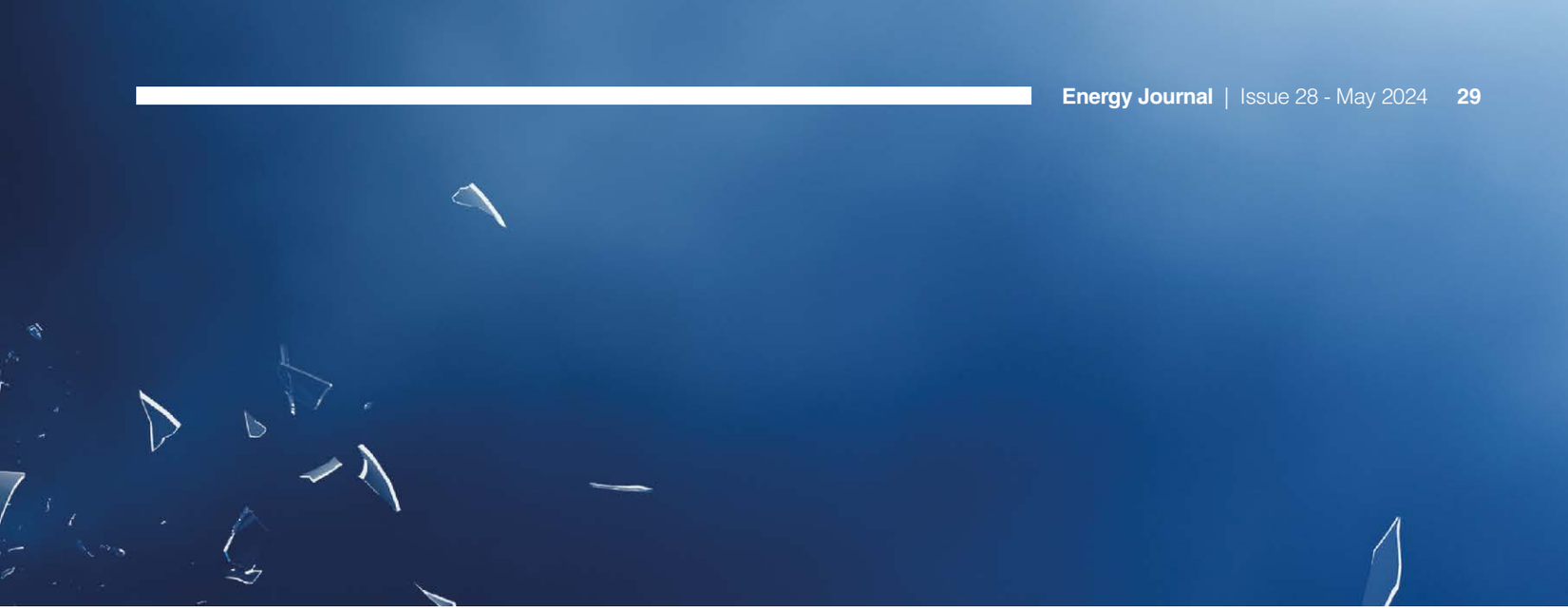
operational costs of the energy system and its emissions by increasing energy trading and the interconnection of regional transmission networks. Modelling results indicate that the **use of advanced flexibility measures introduced by digitalization** – such as the smart charging of electric vehicles, Demand Response, and electricity storage – will promote the reliable integration of extremely high shares of variable generation without any substantial reduction in variable renewable energy (VRE) by 2035, **while also reducing the operative costs of the energy system by 2-11%**.

Thanks to a series of reforms, China is therefore enjoying significant savings and a greater integration of renewable energy resources, efficiently eliminating the problem of VRE production limitation thanks to greater interconnection and competition. **In fact, the implementation of digital technology allows better matching of supply and demand from increasingly heterogeneous decentralized resources.** The IEA study indicates that China has especially concentrated on the expansion of EV charging infrastructure and the introduction of smart meters in order to improve efficiency, resilience, and the reduction of emissions in the energy sector.

Speaking of electric mobility, the global sale of electric vehicles has reached a record level: 10 million units in 2022, a nearly tenfold increase in just five years. However, nearly 95% of sales concern the United States, Europe, and China. According to yet another IEA study, **in 2022, China accounted for 60% of global EV sales**. Indeed, the Asian country has already exceeded its 2025 objective for EV sales. With the rise in electric vehicle adoption, there will be a greater demand on the electric grid that will require an improved integrated V2G planning.

For further information on this topic, please contact:

Daniele Daminelli (Group IT Director)
daniele.daminelli@cesi.it



Top Story

AI and Energy: The New Power Couple

Artificial intelligence and big data are transforming the energy sector, improving efficiency, optimizing distribution networks, and contributing to energy supply and demand forecasts. Such a far-reaching digital revolution also raises issues that operators and authorities are working to address. In the meantime, data centers are devouring large quantities of energy.

The issue of AI is omnipresent; so, in order to better understand the debate, we should begin with current affairs. In mid-March 2024, the **approval of the AI ACT by the European Parliament** marked a historical milestone in the global regulation of artificial intelligence, establishing an international standard for its responsible use. With 523 favorable votes, Europe took a clear stance: **this *pioneering* legislation aims to balance technological innovation with the safeguard of human rights and European values**. By placing individuals at the center of AI development, the EU reaffirms its leading position as a regulator of the digital economy, following up on the success of previous legislative acts such as the GDPR, the Digital Markets Act, and the Digital Services Act.

The result of focused negotiations, the AI ACT establishes clear requisites and limits, especially in terms of potentially invasive technology such as biometric recognition. Moreover, it aims to **protect consumers and democracy itself from manipulation and abuse**. Thus, the act demands transparency for all content generated (or manipulated) by AI. In the context of advanced regulation, artificial intelligence and big data are destined to transform the energy sector in a responsible manner, promoting efficiency, network optimization, and improved forecasting of energy demand and supply, whilst respecting values and regulations.

Advanced Tools for the Management of Big Data

A few months earlier, in November 2023, in an article entitled "**Why AI and Energy are the New Power Couple**," IEA analysts addressed the core issue, explaining that the future management of electric

> grids would require more powerful analytical tools, with AI playing a fundamental role.

According to the article, the rapid evolution of AI capacity, with a computational power that has doubled every 5 to 6 months since 2010, provides new opportunities for the sector. AI can perform tasks ranging from the recognition of language and images to the automation of processes and the management of enormous volumes of data, outperforming human abilities in terms of speed and calculation. **These advances position AI as the key tool to face the growing complexity of energy systems.** The generation and transmission of an unprecedented quantity of data, such as that generated by smart meters and new energy monitoring devices, underline the importance of AI for the energy sector. It is estimated, for example, that wind turbines worldwide produce over 400 billion data points per year.

Thus, the context is clear. With the increased demand for electricity and our commitment to decarbonization, energy systems are becoming extremely complex. The transition process – shifting from a centralized system in which networks transport energy from centralized electric plants to new systems capable of managing multidirectional energy flows (systems involving a multitude of distributed generators and consumers) – makes energy flow forecasting a true challenge. The growing integration of technology such as EV charging stations and residential solar panels, along with a greater interconnection between the energy system and other sectors, such as transportation and construction, requires an intense sharing of information and advanced tools for management and planning. In this context, artificial intelligence is not only considered a fundamental resource to improve efficiency and stimulate innovation, but also an **actor in a vast potential market valued as high as US$13 billion**, serving over 50 different applications in the energy system.

One of the main applications of AI in this sector concerns the optimization of energy supply and demand forecasting. This is crucial for modern energy systems. It is essential to have an accurate understanding of both the availability of renewable energy and energy requirements. Traditionally, maintenance activity followed a set schedule, such as the periodic inspection of pylons and the subsequent execution of maintenance activities, if required. However, this can lead to waste if maintenance is performed prematurely or even greater risks if it is delayed. Thus, the opportunities provided by **AI and predictive maintenance are fundamental**. Indeed, the rapid analysis of millions of data points allows the constant monitoring and analysis of energy plant conditions and predictive maintenance.

In the IEA article, the analysts also mention an Italian case. In 2019, ENEL had already

begun installing sensors on its powerlines to monitor vibration levels. Machine learning algorithms have been allowing ENEL to identify potential issues and, thanks to the resulting data, identify their causes. The result is that ENEL has reduced power blackouts by 15% on this type of powerlines.

Facing the Risks

Any change, in any sector or industry, brings with it stop-and-gos and detailed analyses. However, without artificial intelligence, **energy system operators and energy service suppliers would run the risk of only partially exploiting the potential provided by new data sources and advanced digital technology**, thereby losing many of the benefits that this technology provides. In parallel, we cannot overlook – and we must therefore face – the risks associated with the use of artificial intelligence in the energy sector. These risks include cybersecurity and privacy issues, potential data distortion and errors, and faulty correlations resulting from inadequate training, insufficient data, and programing errors. Moreover, and we will address this shortly, energy consumption is increasing disproportionately to power the servers that enable AI.

This is further compounded by the lack of skilled professional profiles. The lack of workers trained in artificial intelligence and machine learning is one of the key challenges for the sectors wishing to exploit the potential of AI. Indeed, these are amongst the most in demand profiles on the global job market. **In June 2022, there were 22,000 AI specialists worldwide**, with 61% of large companies in the UK and USA emphasizing the lack of AI experts amongst their personnel. The energy industry, in particular, must face intense competition to attract the best data scientists and programmers. **Therefore, in order to withhold talent, IEA analysts recommend that investments be made**

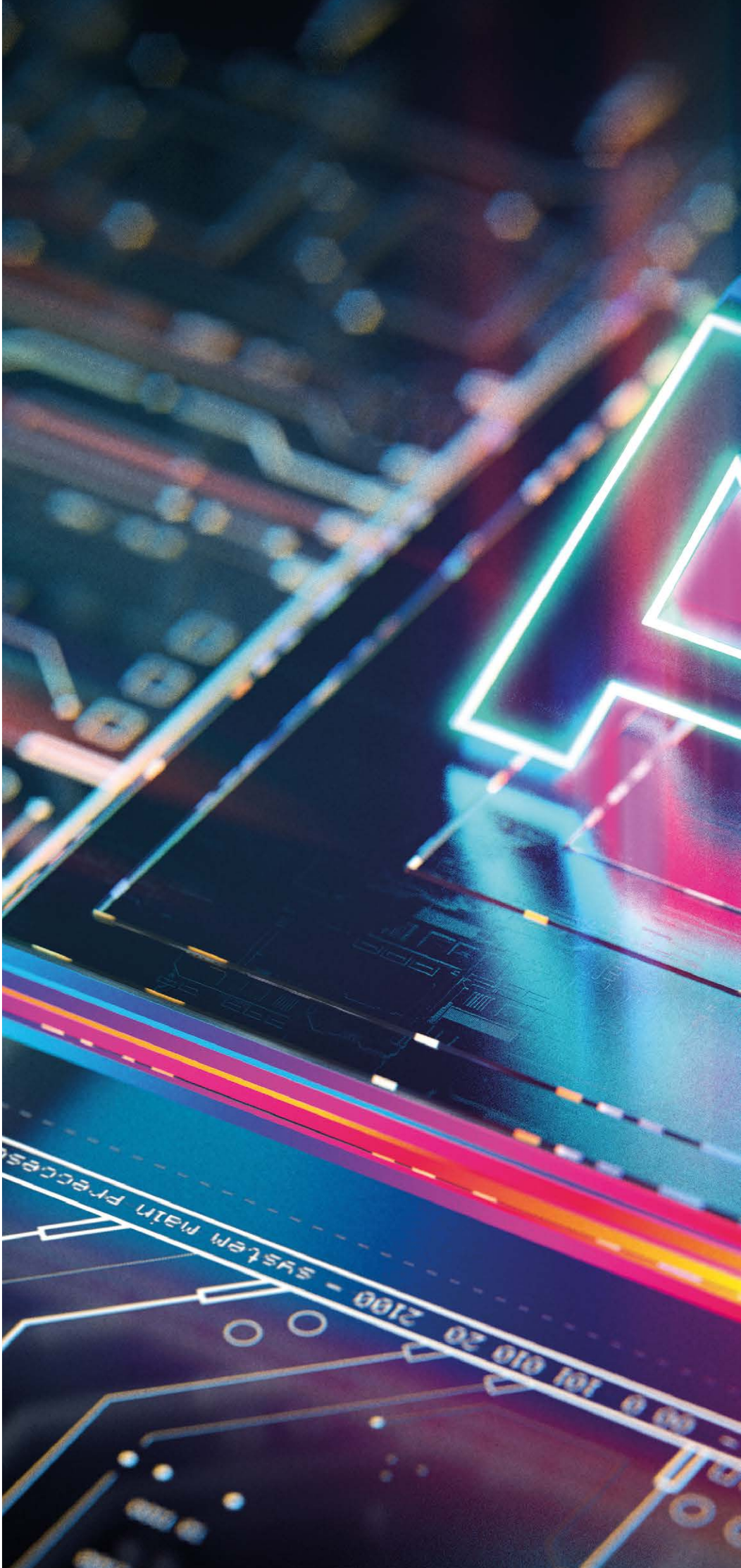
in training and reskilling of the workforce. The contribution of the private and public sectors to digital training courses is essential, although the availability and quality of these initiatives vary significantly amongst the main global economies.

Growing Energy Consumption

The "other side of the coin" is always energy: not as a vector that requires greater efficiency, but as power to drive the servers that manage artificial intelligence systems. The intensive use of AI is associated with a significantly higher consumption of energy than other forms of data crunching. And this is a significant issue in an age aiming to achieve a more sustainable energy system. An example? **Training an artificial intelligence model can require more power than that consumed by 100 American families over the course of an entire year.** Indeed, Google has indicated that, during 2019-22, machine learning accounted for ca. 15% of its total energy consumption. However, notwithstanding the importance of this issue, there has been no systematic collection of data on the energetic and environmental impact of AI. Therefore, greater transparency and monitoring is required.

On the other side of the Atlantic, the debate is heating up. The availability of energy represents a key challenge for the growth of AI systems. In the United States, the exponential rise of AI data centers, the increased production of semiconductors, mining, and the drive for electrification **risk further compromising an already ageing grid**. At the beginning of March, the *Washington Post* reported that vast areas in the United States may not have enough energy due to the diffusion of *electricity-hungry* data centers. New plants, heat pumps, and electric vehicles require ever more energy, leaving suppliers and local authorities seeking new solutions to bolster the national grid.

In fact, the demand for energy in the United States, especially for industry and data centers, is growing at record rates. Forecasts indicate that it will increase seventeen-fold in Georgia over the next ten years, and similar challenges await Arizona and North Virginia. The rapid expansion of data centers and semiconductor plants, together with increased crypto mining, is ramping up the pressure on electric networks, raising questions as to **who will fund the necessary investments to make this growth sustainable**. This situation may slow down the transition towards



cleaner energy sources; indeed, some states are considering postponing the closure of their coal-driven power plants. And with data centers consuming an increasing percentage of the available electricity, the race to identify areas with reliable transmission networks is driving up the cost of land. Some large companies, such as Microsoft, are exploring various options, including nuclear energy, to face this challenge. In the meantime, however, both the national government and individual states are facing a difficult challenge: **balancing the green transition with the growing energy demand caused by technological development**.

Europe: Between the United States and China

European legislation on technological innovation is recognized as a vital measure to **ensure that the development of technology remain aligned with Europe's constitutional values**. While in the United States these regulations have raised a wide debate (and not only amongst members of Congress), in China, legislation is considered indispensable to maintain political control and consolidate state authority.

By contrast, coherently with its founding principles, the European Union is **shaping its AI legislation to safeguard human rights, strengthen democracy, and respect legality**. Although there is a growing interest in the United States for the AI-related issues raised in Europe, there still is a tendency to limit the action of the state in the economy in order to promote private enterprise. Indeed, this reflects America's position as a **pioneer in the field of artificial intelligence**, one focused on national security and global competition, underlining their commitment to remain on the cutting edge of technological innovation.

Thus, the approval of the AI ACT by the European Parliament – mentioned at the beginning of this article – is a fundamental step even with regard to the responsibility for the results produced by such systems. Operators often adopt AI technology or connected services from IT companies and start-ups. This may concern decisions related to energetic equilibrium or investments based on models that may not be fully understood or controllable by operators. Consequently, further questions arise as to whom should be held responsible in cases concerning public spending, variations in the price of energy, and service interruptions.

Conclusions

Returning to our starting point, in the context delineated by the European AI ACT that establishes principles for the responsible development of AI, the **energy industry is moving with a renewed commitment towards innovation, whilst facing significant challenges related to data security and the protection of critical infrastructure**. AI provides powerful tools to analyze vast data sets, allowing an efficient management of energy networks through predictive maintenance and the accurate forecasting of demand. This technology can minimize waste and promote a more rational use of resources, including a greater use of renewable energy.

However, **dependence on sensitive data and critical infrastructure makes the sector an appealing target for cyberattacks**, with possibly serious consequences such as supply failures and market manipulation. The AI ACT focuses on security and data

protection, establishing high standards for transparency and responsibility in the use of AI, thereby ensuring that operations are both efficient and secure.

In this context, it is fundamental for information security managers to adopt proactive measures to protect sensitive data through cryptography, secure access control, and a constant monitoring of networks. The introduction of advanced security solutions, powered by AI itself, can significantly improve the ability to identify and neutralize threats, revealing that **legislation can act as a shield to protect and promote innovation, rather than as a limiting factor**. Indeed, this synergy between regulation and technological innovation is crucial to guarantee a sustainable, safe, and efficient future for energy.

In order for artificial intelligence to become an efficient ally of reliable, decarbonized, and resilient energy systems, **governments must develop mechanisms to share data and governance**. A coordinated global approach will allow solutions to be applied and replicated internationally, transferring experience to the global level, and accelerating the energy transition by reducing its costs.

Future & Technology

CESI: Innovative Solutions for the Space Economy and AI

Italy ranks seventh globally in investments in space technology in relation to its GDP, signaling its significant role in the sector's expansion. As sixty to one hundred thousand new satellites are expected to be launched by 2030, CESI remains at the forefront in the production of advanced space cells for the European Space Program, while also conducting research on network architecture security.

In 2024, private missions to the moon, funded by NASA's CLPS Program, are set to achieve a historic milestone in space exploration by 2024. Companies such as Astrobotic and Intuitive Machines are spearheading the development of lunar landers to transport tools and robots to the lunar surface, inaugurating a new era of logistics based on the sales of transport capacity. **The aim is to reduce mission costs through ridesharing, or secondary payload sharing.** One example of this is the upcoming Intuitive Machines mission that will share the payload cost with the Odin Mission by Astro-Forge, a company seeking to exploit mineral deposits on asteroids. Indeed, the latter will mark two records. It will not only be the first private mission to travel beyond the moon but will also be the first headed to an undisclosed location in space.

It is no mystery that the space economy is in rapid expansion. Forecasts suggest that the space economy will surpass €1000 billion by 2030, with an average annual growth rate of 11% from the €470 billion spent in 2023. **Italy plays a significant role in this sector and ranks seventh in space investments in relation to its GDP.** With a total investment of €4.6 billion and €2.5 billion in sales in the Aerospace sector in 2022, Italy aims to further increase its investments, including €2.3 billion in PNRR funds and €300 million from the Artemis Program, as well as investments for more than €3 billion in the European Space Agency over the next three years.

During a recent webinar organized by PwC Italy on 'Aerospace: Italian Know-how in International Mission Ax-3,' an outlook was presented for the aerospace sector. Particularly noteworthy is the projected 15% increase in segments such as earth observation, satellite communication, and the in-orbit servicing market, with the objective of launching 60,000-100,000 new satellites by 2030.

Over 2015-22, global investments in the space economy reached ca. €50 billion with a significant influx of new investors in 2021 that represented over 61% of the total. These include private equity, venture capital, institutional investors, and private companies. **Italy stands out in the global space industry**, encompassing all segments from launchers to satellite communication

For further information on this topic, please contact:

Davide Piccagli (Automation & Innovative Solutions Product Leader)
davidestefano.piccagli@cesi.it

services. In 2022, the Italian space sector generated a turnover of €2.5 billion in 2022.

The majority of this market (over 92%) is dominated by upstream services, including launchers and space access, while downstream services, such as earth observation and satellite technology, account for the remaining 8%. Thus, the market is highly concentrated. **Large companies account for 90% of the upstream segment and 80% of the downstream segment.** Investments in the space economy have had a growing impact on the Italian GDP, nearly doubling between 2014 and 2020, with an average annual growth of 9.5% and driving an annual 7.1% increment in the space budget.

NASA's Commitment to Solar Energy

Space-based solar power (SBSP) is an innovative frontier for the production of sustainable energy through **projects that aim to collect energy in space and transmit it to Earth wirelessly**. This type of technology could supply energy to remote areas, integrating any existing terrestrial infrastructure. In fact, as a part of the drive to promote net zero carbon emissions by 2050, both countries and international organizations are investing in research and development in this cutting-edge solution.

While **Elon Musk** has stated that we could theoretically satisfy the global energy demand

by covering just 1.2% of the Sahara desert's surface with photovoltaic panels, Project **Space-based Solar Power** aims to collect solar energy in space and convey it to Earth. Space-based solar power (SBSP) offers a promising solution for sustainable energy production. NASA's Office of Technology, Policy, and Strategy (OTPS) is evaluating SBSP's potential benefits, including cost, emission reductions, and technical challenges, (such as assembling and maintaining large systems in orbit), the development of efficient transmission systems, and the management of launch costs. And while in the short term, space-based solar power may be more expensive than existing terrestrial alternatives, **overcoming technical gaps could make it both sustainable and competitive over the long term**.

Sunlight, which is over ten times more intense beyond the earth's atmosphere, could be captured continuously by orbiting photovoltaic cells. This energy could then be converted into electricity and transmitted wirelessly, via microwaves, to Earth stations capable of reconverting the microwaves into electricity for local networks. However, the development of such a system currently presents significant challenges related to the required size of both the terrestrial and space infrastructure and the hundreds of launches that would be required to assemble such a large solar satellite.

In the past, the high cost of space launches meant that solar satellites were less competitive than earth-based energy solutions. Today, however, reduced launch costs mean that **the assembly of solar satellites could be economically advantageous**, delivering on the promise of a never-ending source of clean energy. This development could contribute significantly to the European achievement of net zero carbon emissions by 2050. In fact, an adequately sized solar satellite could produce as much energy as a nuclear plant, providing electricity to more than one million households.

CESI's Research on Solar Cells

While this scenario points to the need to strengthen the space ecosystem – driving collaboration between large organizations and companies/start-ups, improving governance models and synergies between the public and private sectors, and developing international partnerships like the Ax-3 Mission – **innovation remains central to this expansion, driven by technology such as solar cells** that play a fundamental role in shaping the future of space exploration and exploitation.

Nanotechnology is a crucial innovation in the photovoltaic sector. It allows scientists to **work on a microscopic scale to develop materials that improve**

> **the efficiency of solar cells**. Nanostructures, such as quantum dots, allow the absorption and capture of a greater quantity of light and therefore a greater production of electricity. These advanced solar cells are lighter and more flexible than standard ones. Indeed, nanotechnology simplifies the exploration of new materials, such as perovskite, which provides a high efficiency at a cheaper cost than traditional technology. Moreover, it **improves the resistance of solar panels to environmental factors**, prolonging their lifecycles and optimizing return upon investment.

Space solar cells – **which CESI develops, produces, and tests, along with just a few other global companies (one German and two American, in the West)** – transform solar energy into electricity in adverse environmental conditions, providing energy to satellites and space vehicles. They are developed to withstand radiation and extreme temperatures and provide a constant and reliable supply of energy. Thanks to their light and compact nature, space solar cells contribute to **reducing launch costs and optimizing payload capacity**. Moreover, space solar cells provide a sustainable and efficient source of energy that is crucial to the long-term operation of satellites.

Researchers and engineers are working to overcome challenges in the photovoltaic sector through innovation in materials science and production methodologies. Notwithstanding the many issues, the determination and innovative bent of scientists are driving the limits of solar technology. CESI is contributing actively, working on research and development, to make the sector more efficient and less expensive. In fact, **one of CESI's greatest contributions is the production of low-cost space solar cells**, which reduce the need for expensive materials such as gold and silver, making the cells more accessible and cost-effective. Indeed, CESI is renowned for its ability to design and produce advanced space solar cells that have been tested by **ESA's European space** programs and have also contributed to various interplanetary missions (i.e., towards Mercury, Mars, and Jupiter).

CESI has produced over 200,000 solar cells that have been used to power more than

70 civilian satellites for clients in 25 countries. Using proprietary technology, CESI develops a wide variety of space solar cells in its plants in Milan: small and large, single cells and assemblages. Indeed, **CESI can combine all the above-mentioned characteristics to provide custom-tailored space solar cells for any type of space program**. Thanks to its long-standing and close relations with international space agencies and organizations around the world, CESI research investments in this field have been provided by the Italian Space Agency (ASI) and the European Space Agency (ESA).

In this context, CESI has developed a revolutionary methodology – referred to as "integral assembly" – that focuses on the **optimization of the assembly process of space solar cells**. Traditionally, solar cells in space are protected by a thin layer of glass that shields cell components from radiations and micro-meteorites. However, this is not only an expensive method, but it also adds considerable weight to each cell – a significant issue considering the quantity of cells installed on satellites. In collaboration with ASI and ESI, **CESI**

plans to eliminate the need for this glass coating for low-radiation exposition missions. Such an innovation would represent a significant step forward for the space photovoltaic sector, allowing both a reduction in weight and the cost associated with satellite launches.

Artificial Intelligence and Cybersecurity

Thus, technology is increasingly key to a vast panorama and, in particular, to the energy sector, an area that once was the realm of analogic giants. Nowadays, the sector is undergoing a digital transformation driven by artificial intelligence (AI). From optimizing the integration of renewables to demand forecasts and the prevention of blackouts, **artificial intelligence promises a brighter and more sustainable future**. However, great power comes with great responsibility, especially in terms of data security.

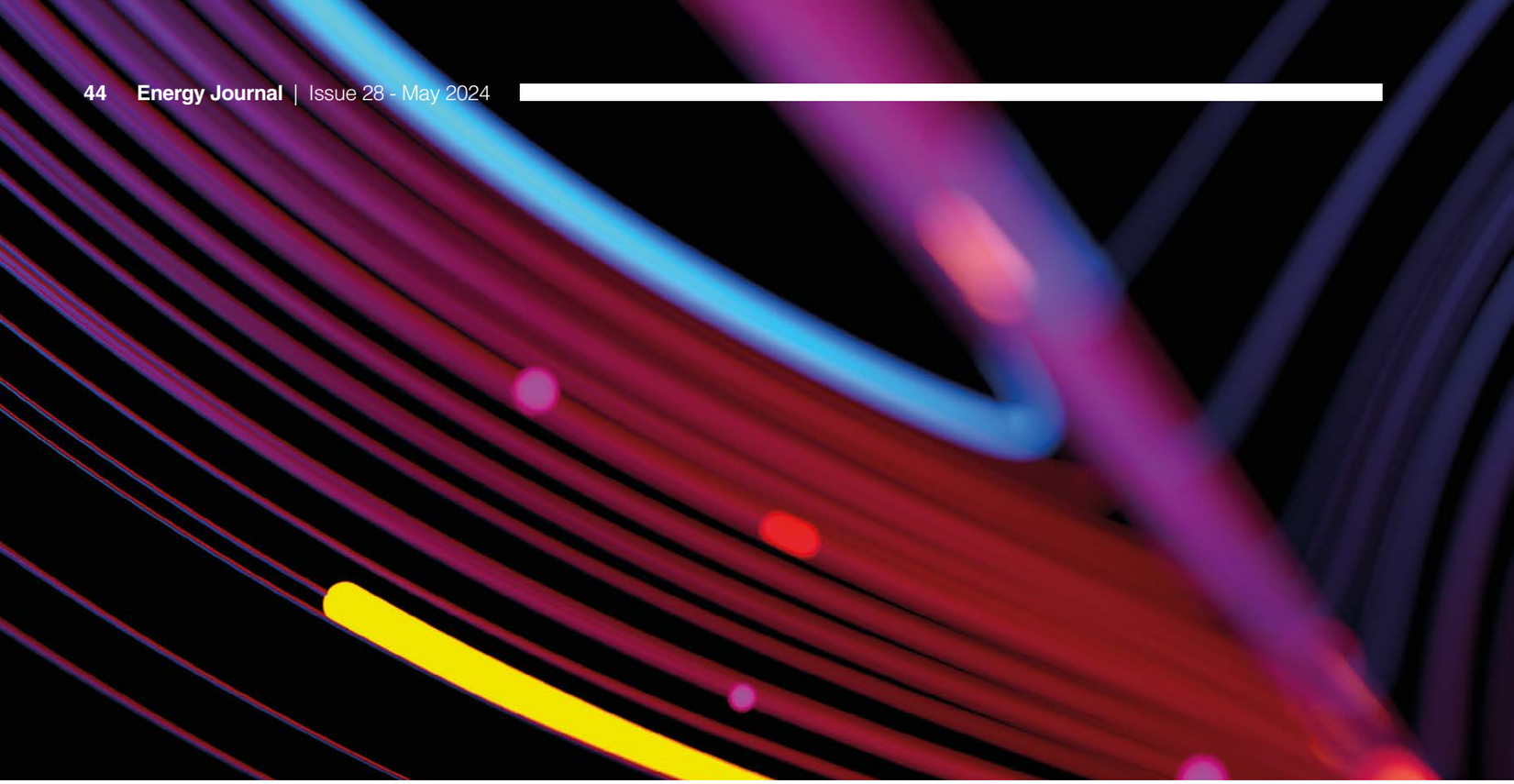
Digital technology enables the filtering, analysis, and conversion into concrete action of the large quantity of data produced by energy systems. For example, sensors and smart meters identify crucial information that is subsequently analyzed by advanced software, generating network operation data, such as that required for energy consumption optimization. And **Generative AI** plays a key role here, too. It is emerging as an **efficient tool to increase the efficiency, resilience, and security of energy transmission and distribution networks**. In the energy sector, this technology simplifies consumption forecasts, optimizes demand management, allows predictive identification of failures or anomalies, and leads to the development of models that can satisfy peak demands during specific periods. In this context, CESI is conducting various projects, both on energy transmission and distribution, analyzing the available (or developing) databases to identify their informational value, defining adequate algorithms to crunch data, and producing significant results to support decision-making processes by sector operators. In fact, the main objective is to create new tools, based on machine learning and/or artificial intelligence, that provide previously unavailable information to support daily activities and system planning.

Besides AI, other digital technology is also crucial to the evolution of electric grids, including **advanced IoT devices**, 5G and 6G connectivity, and the implementation of **digital twins**. In particular, the latter allow operators to simulate and monitor components, systems, and processes in real-time, a fundamental bonus for security assessment, predictive maintenance, and the estimate of asset lifecycles.

In terms of security, **Daniele Daminelli**, CESI IT Director, believes that compliance is not sufficient to consolidate a cybersecurity

culture: “Developing a solid culture of cybersecurity is vital. This requires personnel to prevent abuses, developers to adopt secure coding practices, and a constant commitment to collaborate with colleagues in other sectors and be continuously updated.”

CESI’s IT sector is embarking on an innovative cybersecurity project aimed at enhancing remote access security. The Secure Access Service Edge (SASE) architecture integrates network and security solutions into a cloud-based service, promising improved accessibility, efficiency, and safety for IT assets and applications. **Luca Pantini**, CESI Head of Network, Infrastructure & Security, confirms that SASE will provide “significant improvements in terms of accessibility, efficiency, and safety of our IT assets and company applications, independently of their position.” This new approach provides four key advantages: improved network operation, better network security, reduced costs, and simplified management.



Opinions

Data Management is the Key to Energy System Innovation

Paris Mayor Anne Hidalgo has been working for years to transform the French capital into a smart city with data optimizing energy flows and mobility in the metropolis. Elon Musk, the founder of SpaceX and Tesla, has addressed the issue of the energy required to drive artificial intelligence. Darryl Willis, Vice President of Microsoft's Energy & Resources Industry is certain that AI and machine learning will be used to improve the security of energy networks and prevent cyberattacks. In summary, here are the opinions of a few institutional and business representatives on digital innovation.

Mayor **Anne Hidalgo** has been using artificial intelligence to manage electricity in Paris, promoting the use of innovative technology to improve energy efficiency and drive the use of renewables. The French capital is at the forefront in fostering climate initiatives and the energy transition. A specific example of this is the mayor's support to the Paris Climate Action Plan that aims to transform the capital into a city that is 100% powered by renewable energy. "I'm still working on the creation of a **Parisian Data Center** that will safely and in respect of all legislation store all of the city's data as an excellent example of technology at the service of our political sovereignty."

For a long time, **Elon Musk**'s interest in in artificial intelligence has been closely related to the foundation of SpaceX and Tesla. While SpaceX, his space exploration company, has turned to AI for tasks such as autonomous rocket docking and space vehicle navigation, **Tesla has integrated artificial intelligence into its electric vehicles**, allowing autopilot and self-driving vehicle functionalities. Musk also cofounded OpenAI, a non-profit research organization dedicated to the safe and advantageous progress of artificial intelligence. OpenAI's mission is to guarantee that AI will create advantages for humanity at large: "I'm not critical about artificial intelligence. It's just that dealing with a new and powerful technology is a double-edged blade, like nuclear energy, which can generate a massive amount of energy, but can also be used for weapons. This means that we must understand that artificial intelligence is a very powerful technology that can be used in the wrong manner. And this is why I think we should be extremely cautious."

Artificial intelligence and machine learning can be used to improve the security of energy networks and prevent cyberthreats before they materialize, using data analysis to identify models in energy data that could indicate breaches. **Darryl Willis**, President of Microsoft's Energy & Resources Industry, explains "AI can also empower and enable field workers to identify high-risk tasks and help prevent serious injuries by analyzing large data sets on work sites, schedules, and historical incidents. AI models can be used to predict future supply chain information such as forecasting demand for specific products and optimizing inventory levels."

Elon Musk

The founder of Tesla is an entrepreneur who is famous for his pioneering work in the field of electric vehicles, space exploration, and renewable energy. His involvement in AI initiatives and his outspoken opinions on its potential and possible risks have fueled the debate on the future of this transformative technology.

Indeed, his great interest in AI is revealed by the cofounding, at the end of 2015, of OpenAI, a non-profit research organization dedicated to the **progress of artificial intelligence in a secure and advantageous manner**. OpenAI's mission is to guarantee that AI will bring benefits to all of humanity. Along with other important technological giants such as Sam Altman and Ilya Sutskever, Musk contributed to the initial funding of OpenAI to prevent the concentration of the power of artificial intelligence in just a few hands.

And while Musk eventually resigned from the board of the organization in 2018, he has continued funding its mission and vision. Basically, **OpenAI represents Musk's proactive approach to address his misgivings on the inappropriate use of AI**. The organization conducts cutting-edge research and has published various reports on the matter to guarantee that AI is developed and implemented in a way that it will be safe and benefit society as a whole.

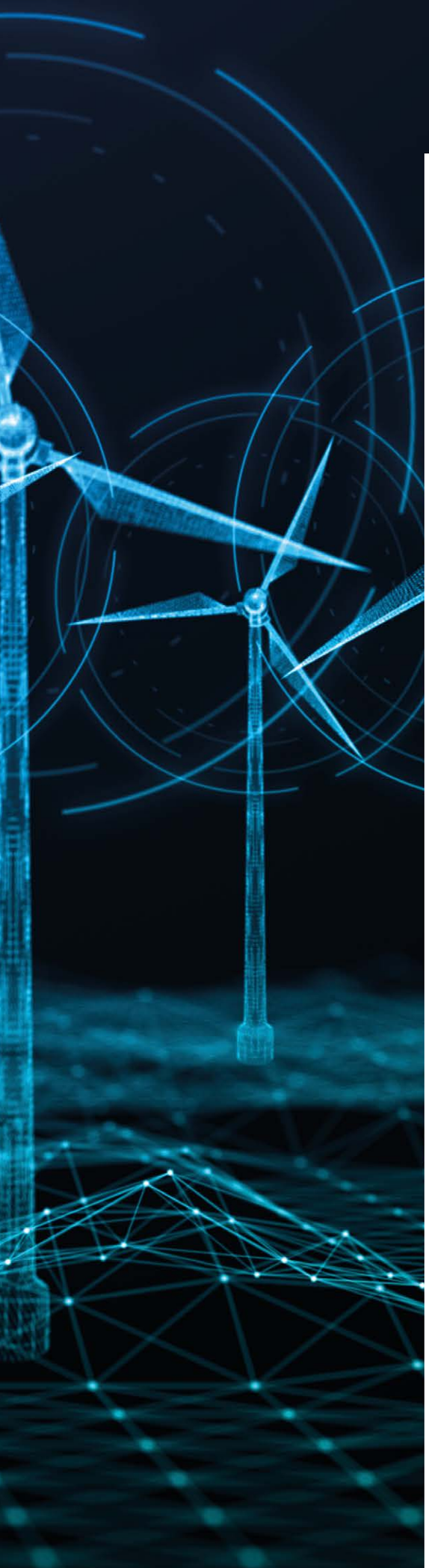
In June 2023, during a trip to Italy, Musk was interviewed by Nicola Porro, Deputy Editor of *Il Giornale*. In the interview, he explained "I'm not critical about artificial intelligence. It's just that dealing with a new and powerful technology is a double-edged blade, like nuclear energy, which can generate a massive amount of energy, but can also be used for weapons. This means that we must understand that **artificial intelligence is a very powerful technology that can be used in the wrong manner**. And this is why I think we should be extremely cautious."

Musk expressed these ideas during a Q&A session held in February 2024 in Berlin at the conclusion of the Bosch Connected World Conference. "I've never seen any technology advance faster than this," explained the Tesla founder. «**The artificial intelligence compute coming online appears to be increasing by a factor of 10 every six months**. Like, obviously that cannot continue at such a high rate forever, or it'll exceed the mass of the universe, but I've never seen anything like it. The chip rush is bigger than any gold rush that's ever existed. I think we really are on the edge of probably the biggest technology revolution that has ever existed."

During the same session, Musk also addressed the lack of chips: "The constraints on AI compute are very predictable... A year ago, the shortage was chips: neural net chips. Then, it was very easy to predict that the next shortage will be voltage step-down transformers. You've got to feed the power to these things. If you've got 100-300 kilovolts coming out of a utility and it's got to step down all the way to six volts, that's a lot of stepping down. [...] Anyway, they're running out of transformers to run transformers. Then, the next shortage will be electricity. They won't be able to find enough electricity to run all the chips. I think next year, you'll see they just can't find enough electricity to run all the chips. The simultaneous growth of electric cars and AI, both of which need electricity, both of which need voltage transformers – I think, is creating a tremendous demand for electrical equipment and for electrical power generation."

Elon Musk's interest in artificial intelligence is closely related to his foundation of SpaceX and Tesla. While SpaceX, his space exploration company, **relies on AI for rocket docking and space vehicle navigation**, Tesla has integrated artificial intelligence into its electric vehicles, allowing autopilot and self-driving vehicle functionalities, thanks to advanced sensors and onboard computers that collect data in real-time.

Replying to *Il Giornale*'s Nicola Porro, Musk denied that the transition toward electric vehicles could represent a problem in terms of electric energy production. "Our planet is already nearly entirely driven by solar energy. We need a mix of the two renewable energy sources: solar and wind. I'm also in favor of nuclear energy, but solar and wind energy allow us to use batteries to store electric energy for when there is no sunlight or wind. In any case, if we have these **three pillars for a sustainable energetic future** to generate sustainable energy (mainly solar, wind, and other sources), batteries to store energy and electric transportation, then we will have a sustainable energy economy for the future."



Anne Hidalgo

Paris Mayor Anne Hidalgo has been working to make the French capital a smart city: "data optimizes energy flows and mobility in our metropolis."

The future is not only about technology, Anne Hidalgo explains. The Mayor of Paris, who was re-elected in 2020 for a second six-year term, believes that a city is truly smart only when it is at the service of citizens. "Today, we have truly understood how important it is to come together physically." Electric vehicles, welcoming migrants, and fighting against inequalities are all part of the same battle, which Hidalgo also conducts preparing for the Paris Olympics of 2024. **It's an opportunity to accelerate the transformation of the city.** "The city of the future will have to satisfy the needs of a new age."

Anne Hidalgo has been using AI to manage Paris's energy, upholding the use of innovative technology to improve energy efficiency and promote the use of renewables. The French capital is at the forefront of climate initiatives and the energy transition, and a specific example is Hidalgo's support to the Paris Climate Action Plan, which aims to power the city with 100% renewable energy.

"As all other cities, Paris is a meeting place for a multitude of intelligences and their vast and precious diversity," Hidalgo explained in an interview to *Il Mattino*. "For a long time, the idea of a smart city was used to justify the massive importation of technology based exclusively on the criterion of efficiency. However, although this is a key criterion for the efficient operation of a city – to optimize energy flows and mobility, for example – but it cannot be the only objective."

Digital Technology for Energy Management

The Paris Climate Action Plan, which is strongly supported by Hidalgo, calls for the use of digital technology to improve the management of energy and promote energy efficiency. Paris aims to develop a local governance system to consolidate its operative resources and promote a decentralized energy model. **This will allow the city to directly control its energy networks and promote their integration with renewables.** A crucial element of this strategy is the creation of a public energy data service, managed by the Paris Climate Agency, which will be responsible for analyzing a large quantity of data, guaranteeing its reliability, and sharing it with various stakeholders. This service will also provide custom-tailored consulting services and detailed analyses to support public policy.

Moreover, Paris will promote initiatives that employ digital platforms to improve the regulation of urban mobility services, simplifying the management of traffic and promoting the use of renewable energy services. Similarly, the city is also committed to improving the energy efficiency of its public buildings. By 2025, all municipal construction projects will benefit from digital building information modelling (BIM) to improve their management and share information on building planning and operativity.

A further innovation will be the development of a three-dimensional Geographical Information System (GIS 3D) to promote urban development and simplify both the energy and the ecological transition. This tool integrates data concerning energy, water, and materials, and will contribute to the evaluation of the environmental impact of urban projects. These initiatives underline the commitment of Paris to digital transformation for the management of urban and energy issues. The objective? Developing a more sustainable and resilient city.

The role of Artificial Intelligence in Energy Management

An overview of the opinions of global managers on the key role that AI plays in shaping the energy panorama.

Companies operating in the energy and resources sector face a complex challenge to guarantee a secure and reliable supply of energy to a global population of 8.1 billion people. At the same time, they need to expand and progress towards a carbon-emissions-free future. In order to face the rapid evolution of demand, regulations, and technology, **the sector is turning to artificial intelligence to accelerate the energy transition** and operate in a more efficient, secure, and sustainable manner.

As Vice President of Microsoft's Energy & Resources Industry, **Darryl Willis** heads a global team to coordinate the digital transformation of the energy sector. "The use of AI," explains Willis, "is increasing the availability and efficiency of renewable energy sources such as solar, wind, hydroelectric, and biomass, which now account for approximately 30 percent of electricity generated worldwide. The World Economic Forum underscores the role AI plays in the energy transition and estimates that every 1 percent additional efficiency in demand creates USD1.3 trillion in value between 2020 and 2050 due to reduced investment needs."

In various industrial sectors, many leaders are adopting **innovative strategies based on the use of data and artificial intelligence** to accelerate the transition towards more sustainable energy and improve operation. "In the energy and resources industry," continues the Microsoft Vice President, "generative AI has the potential to create new solutions and optimize existing processes by enhancing predictive maintenance models which evaluate the current status of equipment and machinery, whether it's a power line, trucks at a mining site, or offshore wind turbines. The AI models can proactively make predictions based on usage trends and consequently inform maintenance teams of potential equipment failures in advance which help energy companies optimize maintenance schedules, minimize equipment downtime, reduce costs, and ensure a safe and reliable energy supply."

Artificial intelligence and machine learning can bolster the security of energy infrastructure by predicting and neutralizing cyberthreats before they cause any damage. The **advanced analysis of data** allows the identification of anomalous patterns in energy systems and may point to potential violations or upcoming threats. As Darryl Willis points out "AI can also empower and enable field workers to identify high-risk tasks and help prevent serious injuries by analyzing large data sets on work sites, schedules, and historical incidents. AI models can be used to predict future supply chain information such as forecasting demand for specific products and optimizing inventory levels."

Energy Systems and Sustainability

A few months ago, journalists at AiThority.com, an on-line magazine specializing in editorials on AI trends and insight, interviewed global managers and CEOs to inquire about the key role played by AI in shaping the energy panorama.

Tim Weiss, CEO of Optera (an American company providing innovative digital solutions to manage sustainability), spoke about the potential of AI to face the challenges related to climate change and the management of energy. Explaining how AI can help optimize energy systems and promote sustainability, he explained "AI will be a useful tool for any business function involving data, including environmental sustainability. Interesting work

is already happening in smart grid management, for example – using AI to analyze data from weather forecasts, sensors, and demand patterns to optimize electricity generation and distribution. In the carbon management space, Optera sees a big opportunity for AI to speed up data cleansing and sharing across systems, allowing sustainability managers to spend more time on analysis and action than on data collection and cleaning."

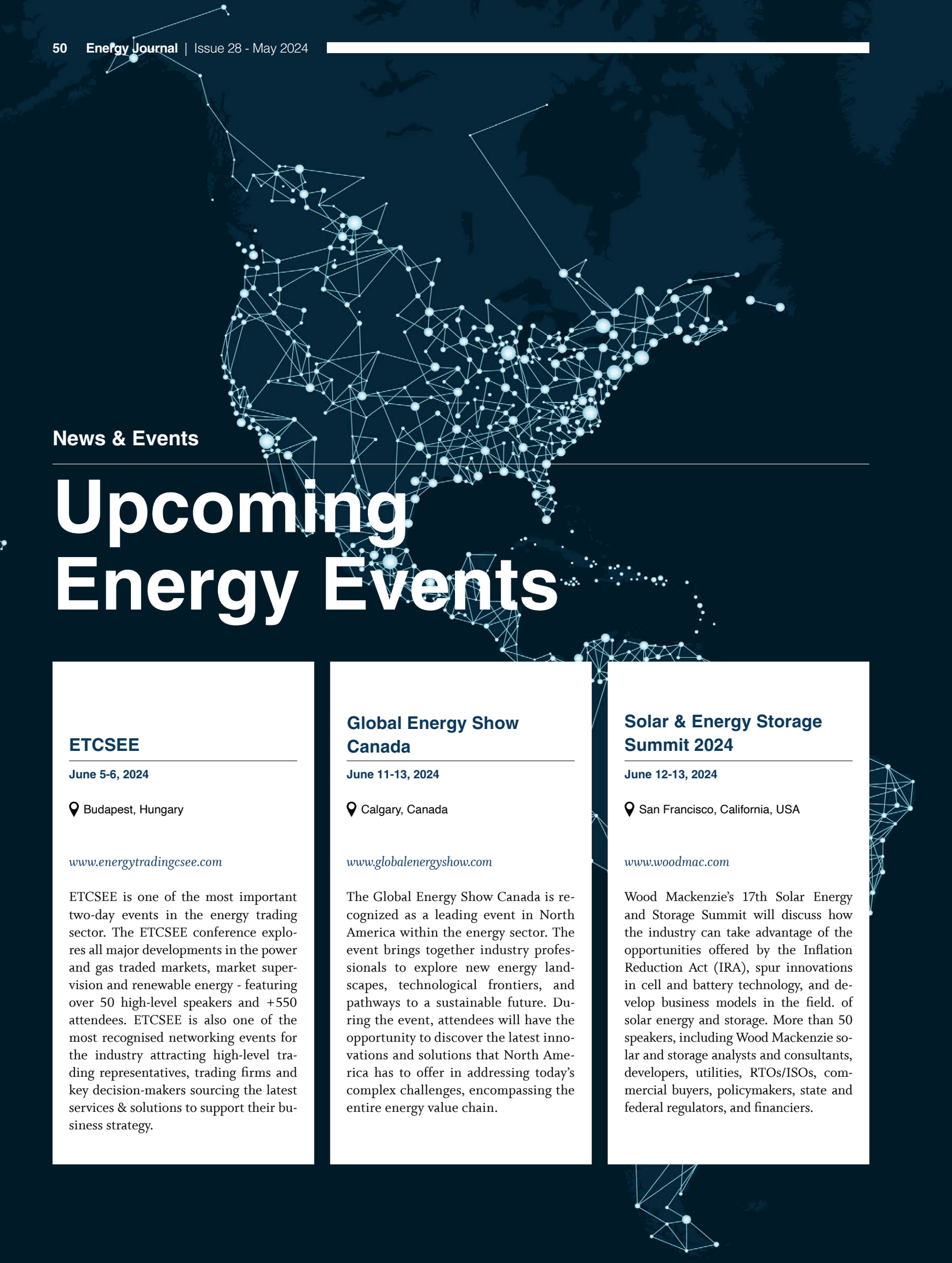
Moreover, **Tim Weiss** added: "AI has the potential to enable practitioners to make timelier and data-driven decisions regarding their de-carbonization journey. This potential must be balanced with the need for accuracy, auditability, and data security. Regulators, researchers, and corporate stakeholders should all have a seat at the table to guide where AI can and should be used."

Adam Tank, co-founder and CCO of Transcend, a generative development platform for critical infrastructure, confirmed that "AI plays a crucial role in improving efficiency and optimizing consumption across the energy sector. Recently, the industry has seen increased investment in demand-management AI applications, where predictive models estimate the amount of future energy various entities on a grid will consume. More accurate demand forecasting enables more efficient resource allocation and load balancing. It also mitigates risk for stakeholders. This AI-powered demand forecasting has grown in popularity both in and outside the home."

Shedding light on some of the aspects on which interested parties should concentrate, **Adam Tank** explained that "besides demand management investments for new energy management infrastructure, stakeholders can also leverage AI to optimize their existing assets, particularly their operations and maintenance processes through predictive failure modeling. By analyzing weather conditions, power line age, maintenance history, load characteristics, and other factors, AI can forecast the likelihood of power line failure during extreme weather conditions."

Artificial intelligence enables demand-response programs that incentivize consumers to reduce the use of energy during periods of peak demand. Intelligent devices controlled by AI and domotics allow consumers to actively participate in demand-response initiatives, reducing network load and promoting a greener energy ecosystem.

This point was also addressed by **Erin Keys**, Senior Product Marketing Manager at Uplight, a technological partner for companies that supply clean energy: "As the presence of Distributed Energy Resources (DERs), such as smart thermostats, electric vehicles, and home batteries increases at an unprecedented rate over the coming years, identifying, managing, and orchestrating their potential beneficial contributions to the grid and towards decarbonization will get increasingly complicated by orders of magnitude. Not only is each type of DER increasing (Brattle Group, for example, is forecasting smart thermostat penetration to go from 10% penetration today to 34%, EVs from 3 million today to 26 million, and behind-the-meter batteries from 2GW of capacity to 27GW, all by 2030), but households will soon have multiple DER types under one roof that may or may not play well together. AI's ability to manage a large and complex portfolio of assets to shape load for the grid in times of need will make these resources as reliable as, or more reliable than, a power plant, and it will do so much more cheaply."



News & Events

Upcoming Energy Events

ETCSEE

June 5-6, 2024

Budapest, Hungary

www.energytradingcsee.com

ETCSEE is one of the most important two-day events in the energy trading sector. The ETCSEE conference explores all major developments in the power and gas traded markets, market supervision and renewable energy - featuring over 50 high-level speakers and +550 attendees. ETCSEE is also one of the most recognised networking events for the industry attracting high-level trading representatives, trading firms and key decision-makers sourcing the latest services & solutions to support their business strategy.

Global Energy Show Canada

June 11-13, 2024

Calgary, Canada

www.globalenergyshow.com

The Global Energy Show Canada is recognized as a leading event in North America within the energy sector. The event brings together industry professionals to explore new energy landscapes, technological frontiers, and pathways to a sustainable future. During the event, attendees will have the opportunity to discover the latest innovations and solutions that North America has to offer in addressing today's complex challenges, encompassing the entire energy value chain.

Solar & Energy Storage Summit 2024

June 12-13, 2024

San Francisco, California, USA

www.woodmac.com

Wood Mackenzie's 17th Solar Energy and Storage Summit will discuss how the industry can take advantage of the opportunities offered by the Inflation Reduction Act (IRA), spur innovations in cell and battery technology, and develop business models in the field. of solar energy and storage. More than 50 speakers, including Wood Mackenzie solar and storage analysts and consultants, developers, utilities, RTOs/ISOs, commercial buyers, policymakers, state and federal regulators, and financiers.

The smarter E Europe 2024

June 19-21, 2024

Munich, Germany

www.thesmartere.de

«Accelerating Integrated Energy Solutions» – that's the goal of The smarter E Europe, Europe's largest alliance of exhibitions for the energy industry. The aim is to create a future-oriented energy world by shining a spotlight on renewable energies, decentralization and digitalization as well as cross-industry solutions from the electricity, heat and transport sectors for a sustainable 24/7 energy supply.

International Energy Workshop 2024

June 26-28, 2024

Bonn, Germany

www.irena.org

The International Energy Workshop (IEW) is a leading conference for the international energy modelling community. In a world of environmental and economic constraints, energy modelling is an increasingly important tool for addressing the complexity of energy planning and policy making. The IEW provides a venue for scholars and researchers to compare modelling tools, to discuss modelling advances for emerging energy sector issues, and to observe new trends in the global energy sector.

2024 Cybersecurity & Technology Innovation Conference

July 29 - August 1, 2024

Dallas, Texas, USA

www.doecybercon.com

The DOE Cybersecurity and Technology Innovation Conference will focus on key issues such as cybersecurity developments, technological advancements, workforce development, and critical infrastructure protection. The event will bring together thought leaders from the DOE, federal agencies, academia, international partners, and the private sector to discuss modernization of IT and OT environments, data management, tool sharing, and best practices in energy industry cybersecurity.

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. In particular, through its Division KEMA Labs, CESI is the world leader for the independent Testing, Inspections and Certification activities in the electricity industry. 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 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, Knoxville (USA) and Chalfont (USA).

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