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SEE ENERGY BRIEF

Monthly Analysis

The Future of AI and Energy - Impact on SE Europe

Introduction

Over the last few years, Artificial Intelligence (AI) has soared to the top of the political, economic and business agenda. Once a mostly academic pursuit, it has evolved into an industry with trillions of dollars at stake. Despite significant uncertainties, it is now very clear. AI is coming. In many sectors, it is already here. This has major consequences for the global energy sector. There is no AI without energy – specifically electricity. At the same time, AI has the potential to transform the sector's future.

The energy sector is therefore at the heart of one of the most important technological revolutions today. However, there is still a lack of understanding of the stakes and implications of this deepening connection between energy and AI. According to the IEA **(1)**, global investment in data centres has nearly doubled since 2022 and amounted to half a trillion dollars in 2024. This investment boom has led to growing concerns about skyrocketing electricity demand. Data centres accounted for around 1.5% of the world's electricity consumption in 2024, or 415 TWh. The United States accounted for the largest share of global data centres' electricity consumption in 2024 (45%), followed by China (25%) and Europe (15%). The current Analysis examines in some detail the current and future status of AI in terms of energy and how this combination may have impact on the wider region of SE Europe.

Current and Future Situation of AI and Energy Globally

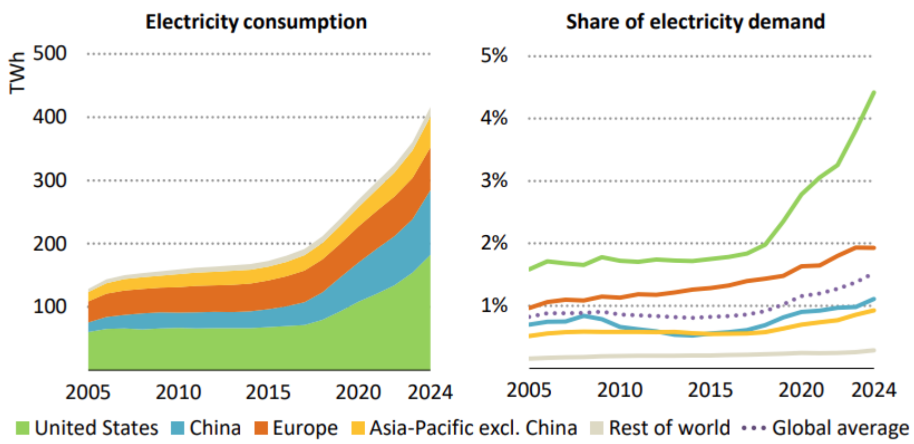
The global intersection of AI and energy is becoming increasingly important, driven by the urgent need to modernize energy systems, integrate renewables, and combat climate change. AI technologies are now at the forefront of optimizing how energy is generated, distributed, and consumed. As the demand for clean and efficient energy grows, AI offers tools to make systems smarter, more resilient, and more responsive to both supply fluctuations and consumer behavior. Governments and energy providers around the world are recognizing this potential and are increasingly investing in AI-based energy solutions.

One of the most impactful applications of AI is in managing electricity grids. With the rise of decentralized and intermittent energy sources, such as solar and wind, maintaining grid stability has become more complex. In this context, AI is used to predict energy demand and supply patterns in real-time, balance loads across networks, and quickly respond to faults or fluctuations. This capability not only improves reliability but also reduces operational costs. In countries, such as the United States, China, and parts of Europe, AI-enabled grid management is already helping to make energy systems more efficient and less carbon-intensive. **(2)**

AI is also transforming how we integrate renewable energy into national energy mixes. Predictive analytics powered by AI allow operators to forecast solar radiation or wind speed with high accuracy, enabling better planning and storage strategies. This reduces reliance on fossil fuel-based backup systems and enhances the role of renewables. In Germany and the Netherlands, for example, AI tools are helping to stabilize grid input from fluctuating wind farms, while also informing battery storage and grid expansion decisions. (3)

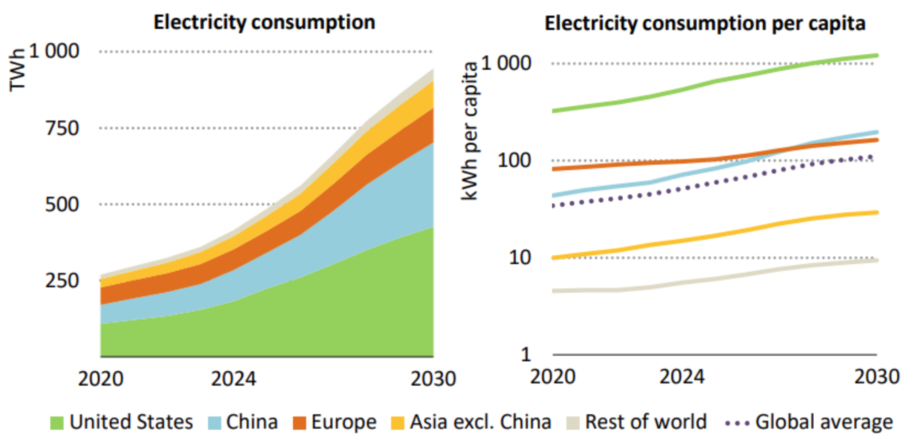
Beyond generation and grid operation, AI is making a substantial impact on energy consumption optimization. Smart buildings equipped with AI-driven energy management systems can optimize lighting, heating, and cooling based on occupancy and weather forecasts. This not only reduces energy waste but also lowers emissions and utility costs. Tech companies and building management firms around the world, particularly in North America and Asia, are adopting AI for smart energy management at both residential and commercial levels.

Figure 1: Electricity Consumption of Data Centres by Region, 2005-2024



Source: IEA

Figure 2: Data Centres' Electricity Consumption and Its Consumption per Capita by Region in the IEA's Base Case[1], 2020-2030



Source: IEA

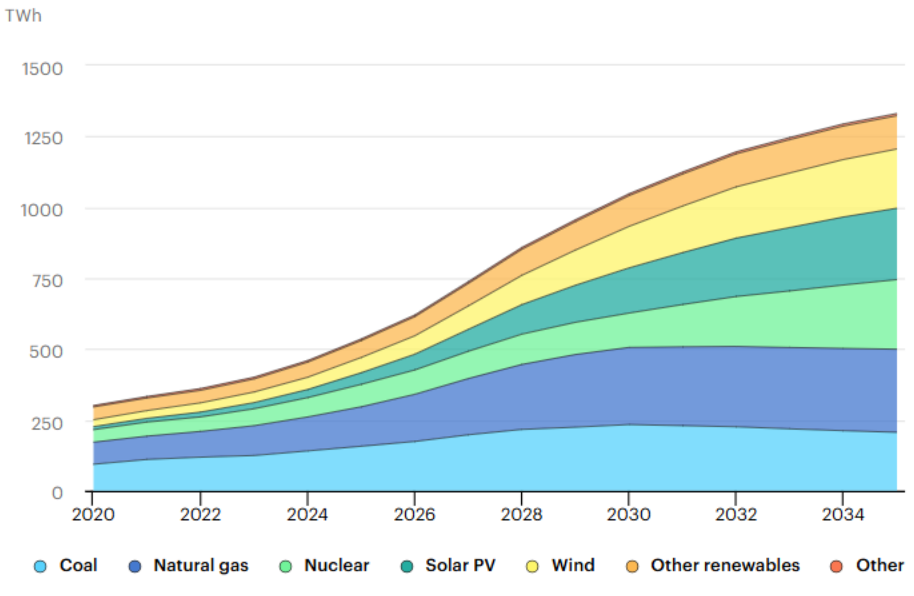
[1] The IEA's Base Case explores the trajectory of electricity consumption in data centres under current regulatory conditions and industry projections. The key driver in this case in the near term is industry projections for server shipments to 2028 and a continuation of this trend after 2028. Efficiency improvements are expected to continue playing a pivotal role in limiting strong growth in energy consumption, despite increasing demand for digital services.

In the field of maintenance and infrastructure management, AI is revolutionizing how utilities approach system upkeep. Through predictive maintenance, AI algorithms analyze sensor data from equipment like transformers, turbines, and pipelines to anticipate failures before they occur. This reduces downtime, extends equipment lifespan, and prevents potentially hazardous incidents. Energy giants, such as Enel, GE, and TotalEnergies, have adopted these methods to streamline operations and cut maintenance costs. **(4)(5)**

Despite the promise of AI in the energy sector, several challenges remain. Data accessibility and standardization continue to be major barriers, especially in regions with fragmented infrastructure or outdated systems. Cybersecurity risks are also heightened as more energy assets become digitally connected. In addition, the regulatory environment for AI in energy is still evolving, with a lack of common standards around transparency, safety, and ethical use. Ensuring that AI systems are explainable and accountable is critical, particularly in critical infrastructure contexts.

In 2024, data centres accounted for 1.5% of worldwide electricity demand. By 2030, this share is set to rise to about 3% in the IEA's base case (see Figure 3), with electricity demand from data centres worldwide more than doubling to around 945 TWh. That is slightly more than the entire electricity consumption of Japan today. While this is still a relatively small portion of the global total, the effects are poised to be particularly strong in some countries. For example, in the United States, data centres are on course to account for almost half of the growth in electricity demand to 2030, more than half in Japan and as much as one-fifth in Malaysia. A diverse range of energy sources will be tapped to meet data centres' rising electricity needs globally – though renewables and natural gas are currently set to take the lead due to their cost-competitiveness and availability in key markets.

Figure 3: Sources of Global Electricity Generation for Data Centres in the IEA's Base Case, 2020-2035



Source: IEA

Current and Future Situation of AI and Energy in Europe

AI is rapidly advancing, transforming industries across Europe. With the European Green Deal and the REPowerEU plan setting ambitious goals, AI has become a central focus in the push for a more sustainable and secure energy future. Energy storage systems across Europe are also benefiting from AI. Batteries and other storage technologies are critical to buffering intermittent renewable power, and AI optimizes their operation by determining when to charge or discharge based on price signals, demand forecasts, and weather predictions. This improves the economic viability of storage solutions, while supporting greater renewable penetration. Projects like Horizon Europe and national innovation programmes are funding AI research aimed at enhancing the performance and coordination of storage networks.

In the building and industrial sectors, AI-driven energy management systems are reducing energy consumption and emissions. Smart thermostats, lighting, and HVAC systems use AI algorithms to learn usage patterns and optimize energy usage without compromising comfort. At a larger scale, industrial AI platforms help factories monitor equipment performance and reduce waste. European companies, such as Siemens, Schneider Electric, and ABB, are leading this area, offering integrated AI solutions for both public and private sector energy consumers. **(6)**

Policy and regulation in the EU are evolving to support this technological shift. The European Commission's digital and energy strategies recognize AI as a critical component of energy system modernization. Efforts are underway to harmonize data standards and governance, which are crucial for the deployment of trustworthy and interoperable AI solutions. Additionally, the proposed AI Act categorizes AI systems in the energy sector as high-impact, requiring strict transparency and accountability measures, especially when used in infrastructure management or consumer applications.

More specifically, the European Union's AI Continent Action Plan **(7)** aims to position Europe as a global leader in AI development. In the energy sector, AI is transforming infrastructure to boost efficiency, resilience, and sustainability. Hence, the European Commission is advancing digitalisation and AI development of Europe's energy systems, with one of the key initiatives being the provision of high-quality, and real-time data.

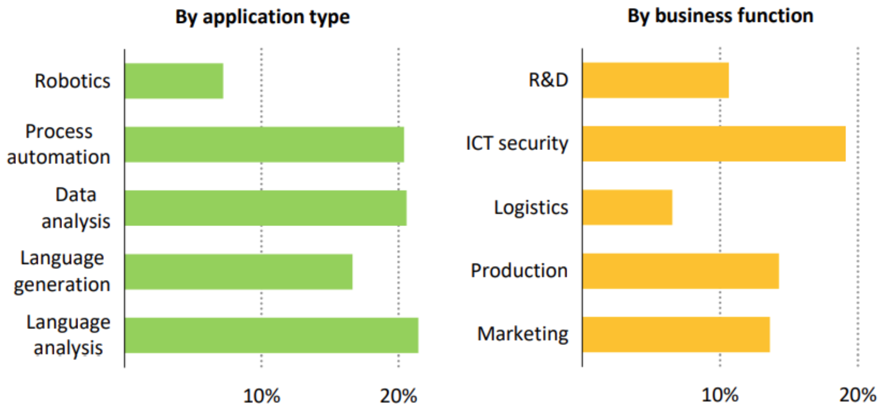
The Common European Energy Data Space (CEEDS) **(8)** is an initiative from the European Commission that aims to create a secure, interoperable, and standardised framework for sharing energy-related data across borders and sectors. By providing access to large volumes of energy data - from electricity consumption to energy production data for wind turbines and solar panels - open data enables AI to perform comprehensive analyses and make smart decisions. These improvements enable growth in the energy sector by leading to better management of renewable energy sources, more efficient energy use, and enhanced grid performance.

One of the projects leveraging the robust data infrastructure established by the CEEDS is the AI-EFFECT Project **(9)**, which aims to improve access to the tools and facilities needed for developing, testing, and validating AI solutions in the energy sector. By creating Testing and Experimentation Facilities across Europe, AI-EFFECT's objective is to ensure that AI technologies are rigorously tested and validated in real-world conditions. This fosters a more resilient and adaptive energy infrastructure.

Despite this progress, challenges remain. Data fragmentation, lack of interoperability, and skills shortages hinder broader AI deployment across EU member states. Smaller utilities and municipalities may lack the resources or expertise to implement AI solutions at scale. Moreover, questions about cybersecurity, ethical AI use, and long-term sustainability continue to be debated. Addressing these challenges will require coordinated action between policymakers, industry, and civil society, including investment in education and digital infrastructure.

Data centres account for slightly less than 2% of Europe's electricity consumption, a share that is higher than China's (1.1%). However, in absolute terms, Europe's consumption is lower, at an estimated 70 TWh in 2024. Europe's share of the global electricity consumption of data centres has decreased over the past decade but still represents slightly above 15%. In Europe, electricity consumption for data centers is expected to increase by more than 45 TWh (up 70%) by 2030. Renewables and nuclear are set to supply most of the additional electricity required, with their combined share rising to 85% by 2030.

Figure 4: Percentage of Large Firms Reporting Using AI by Application Type and Business Function in the EU, 2024



Source: IEA

It is worth noting that data centres in the European Union fall under the scope of the Energy Performance of Buildings Directive **(10)**, which mandates the installation of building automation and control systems. This requirement aims to enhance grid compatibility, enabling data centres to better respond to external grid signals and support flexibility markets. At the same time, the European Union's latest Energy Efficiency

Directive **(11)** requires data centres with a total installed capacity over 1 MW to utilize waste heat recovery or show that such recovery is technically or economically unfeasible.

Current and Future Situation of AI and Energy in SE Europe

AI is becoming an essential component in the modernization of the global energy industry. In SE Europe, a region composed of diverse economies and energy systems, AI offers tools to improve efficiency, increase the share of renewable energy, and reduce operational costs. The region includes countries, such as Greece, Bulgaria, Romania, Serbia, Albania, North Macedonia, Bosnia and Herzegovina, Montenegro, and others, each with unique energy challenges. Many countries in this area still rely heavily on coal and other fossil fuels, though there is increasing pressure to decarbonize and meet European climate targets.

AI technologies are being applied across the energy value chain: from production and transmission to distribution and consumption. In energy generation, AI can optimize the operation of power plants, especially those using renewable energy sources, by predicting weather patterns and energy output more accurately. Predictive maintenance is one of the earliest AI applications adopted in energy systems. Using sensor data and machine learning, utilities can detect faults in turbines, transformers, and pipelines before they cause failures. This reduces costly unplanned outages and extends asset lifespans, a critical benefit in SE Europe where infrastructure is often outdated.

SE Europe is also seeing some pilot projects and early-stage implementations of smart grid technologies, which rely on AI to dynamically balance energy supply and demand. Countries like Romania **(12)** and Greece **(13)** are developing smart grid capabilities to manage distributed energy resources more effectively. Smart grids enable real-time data monitoring and control, allowing grid operators to make informed decisions quickly. This is vital for integrating intermittent renewable energy sources like wind and solar, which are gaining traction in the region thanks to favorable geography and EU funding.

AI-driven demand forecasting is another important application. Machine learning algorithms can analyze historical consumption patterns, weather data, and socio-economic indicators to predict electricity demand more accurately. This helps utilities plan generation and reduce energy losses.

At consumer level, smart meters and AI-enabled home energy management systems empower users to monitor and reduce their energy usage. These tools are beginning to emerge in urban areas of Bulgaria, Greece, and Croatia, where digital infrastructure is more developed. AI also plays a critical role in the development of energy storage strategies. By analyzing grid conditions and renewable output, AI can determine the best times to store and release energy, making storage systems more cost-effective and reliable. In industrial sectors, AI can be used to optimize energy-intensive processes, such as in manufacturing and mining operations found in countries like Serbia and North Macedonia. This not only reduces costs but also supports decarbonization goals.

Energy trading is another area where AI has the potential to drive major changes. Algorithmic trading platforms can assess real-time market data, policy changes, and cross-border flows to make efficient trading decisions. This could strengthen regional cooperation and energy security.

However, there are considerable challenges to scaling AI in the energy sector across SE Europe. One major obstacle is the uneven development of digital infrastructure, particularly in rural or economically disadvantaged regions. A lack of skilled labor in both AI and energy technologies is another barrier. Many countries in the region are experiencing brain drain, with highly trained professionals seeking better opportunities abroad. This limits the local talent pool needed for digital innovation.

Regulatory frameworks are also lagging behind technological developments. Existing energy regulations often do not accommodate the flexible and data-driven nature of AI, slowing down the approval and implementation of new systems.

Last but not least, cybersecurity is a permanent concern. As energy systems become more connected and reliant on digital tools, they also become more vulnerable to cyberattacks. Ensuring data security and system resilience must be a top priority for governments, independent authorities, system operators and utilities alike. Funding remains a critical issue. While EU support and international partnerships offer some capital, many projects in the region struggle to attract long-term private investment due to political instability, corruption concerns, and market uncertainty.

Despite these challenges, there are promising signs of progress. Countries like Greece are emerging as leaders in renewable integration and digital energy initiatives **(14)**, while Romania is leveraging its strong IT sector to pilot AI-based energy solutions. Cross-border collaborations, such as those encouraged by the Energy Community and EU Green Deal, are also helping to harmonize policies and share best practices. These partnerships are essential for scaling AI technologies and addressing regional energy security.

In the future, the role of AI will only grow. As electricity demand rises and renewable energy sources expand, SE Europe will need increasingly sophisticated tools to manage complexity. AI offers a clear path to achieving both efficiency and sustainability goals. To succeed, governments must invest in education, support digital innovation, and reform regulation regimes. With strategic planning and international cooperation, SE Europe can turn its current energy challenges into opportunities through the intelligent use of AI.

Discussion

The importance of AI in the energy sector is growing rapidly, transforming how energy is generated, distributed, consumed, and managed. As the world transitions to cleaner, smarter, and more resilient energy systems, AI serves as a powerful enabler. It helps utilities, governments, and consumers make better-informed decisions, optimize efficiency, reduce emissions, and enhance system reliability in real time.

One of AI's most significant roles is in managing the complexity of modern power grids, which must now accommodate decentralized, intermittent renewable sources like wind and solar. AI algorithms can forecast energy demand and generation with high accuracy, balance supply and demand dynamically, and detect and respond to faults more quickly than human operators. This helps prevent blackouts, reduce energy waste, and integrate higher levels of renewables without sacrificing grid stability.

AI also plays a crucial role in predictive maintenance and asset management. By analyzing data from sensors embedded in infrastructure—such as turbines, transformers, and pipelines—AI can detect anomalies and predict equipment failures before they occur. This reduces unplanned downtime, extends the life of assets, and lowers maintenance costs, which is especially critical for large-scale energy infrastructure that is costly and time-intensive to repair.

In summary, AI is becoming essential to the modernization and decarbonization of the energy sector on a global, European and SE European basis. Its ability to process vast amounts of data, learn from complex patterns, and make intelligent decisions in real time makes it a cornerstone of the future energy system. As challenges around energy security, affordability, and sustainability intensify, AI will remain a critical tool for creating smarter, greener, and more equitable energy solutions.

References

1. IEA (2025), "Energy and AI", https://iea.blob.core.windows.net/assets/34eac603-ecf1-464f-b813-2ecceb8f81c2/EnergyandAI.pdf
2. Rajaperumal, T.A., Columbus, C.C. (2025), "Transforming the electrical grid: the role of AI in advancing smart, sustainable, and secure energy systems", Energy Inform 8, 51, https://doi.org/10.1186/s42162-024-00461-w
3. Kacher, A. (2025), "Dutch power grid operator allocates 9 GW via off-peak contracts", https://www.reuters.com/business/energy/dutch-power-grid-operator-allocates-9-gw-via-off-peak-contracts-2025-04-07/
4. Karigiannis, J. (2025), "Enhancing operational efficiency in the energy sector with artificial

intelligence", https://www.gevernova.com/gas-power/resources/articles/2025/ai-operational-efficiency-energy-sector

5. TotalEnergies (2025), "AI, Expediting the Energy Transition", https://totalenergies.com/news/news/ia-expediting-energy-transition
6. ABB (2025), "ABB invests in generative AI energy manager startup Edgecom", https://new.abb.com/news/detail/122481/abb-invests-in-generative-ai-energy-manager-startup-edgecom
7. European Commission (2025), "AI Continent Action Plan", https://digital-strategy.ec.europa.eu/en/library/ai-continent-action-plan
8. European Commission (2023), "Common European Energy Data Space", https://energy.ec.europa.eu/publications/common-european-energy-data-space_en
9. AI-EFFECT (2025), "Artificial Intelligence Experimentation Facility For the Energy sector", https://ai-effect.eu/
10. European Union (2024), "Directive (EU) 2024/1275 of the European Parliament and of the Council of 24 April 2024 on the Energy Performance of Buildings (recast)", https://eur-lex.europa.eu/eli/dir/2024/1275/oj/eng
11. European Union (2023), "Directive (EU) 2023/1791 of the European Parliament and of the Council of 13 September 2023 on energy efficiency and amending Regulation (EU) 2023/955 (recast)", https://eur-lex.europa.eu/eli/dir/2023/1791/oj/eng
12. Todorović, I. (2024), "Romania grants €418 million for power distribution grid upgrades", https://balkangreenenergynews.com/romania-grants-eur-418-million-for-power-distribution-grid-upgrades/
13. Reuters (2024), "Helleniq Energy to boost renewables but cautious over power grids", https://www.reuters.com/business/energy/helleniq-energy-boost-renewables-cautious-over-power-grids-2024-05-16/
14. Lardizabal, E. (2024), "Greece implements a new framework to boost 4.7 GW of energy storage and reduce grid congestion", https://strategicenergy.eu/greece-storage-grid/

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