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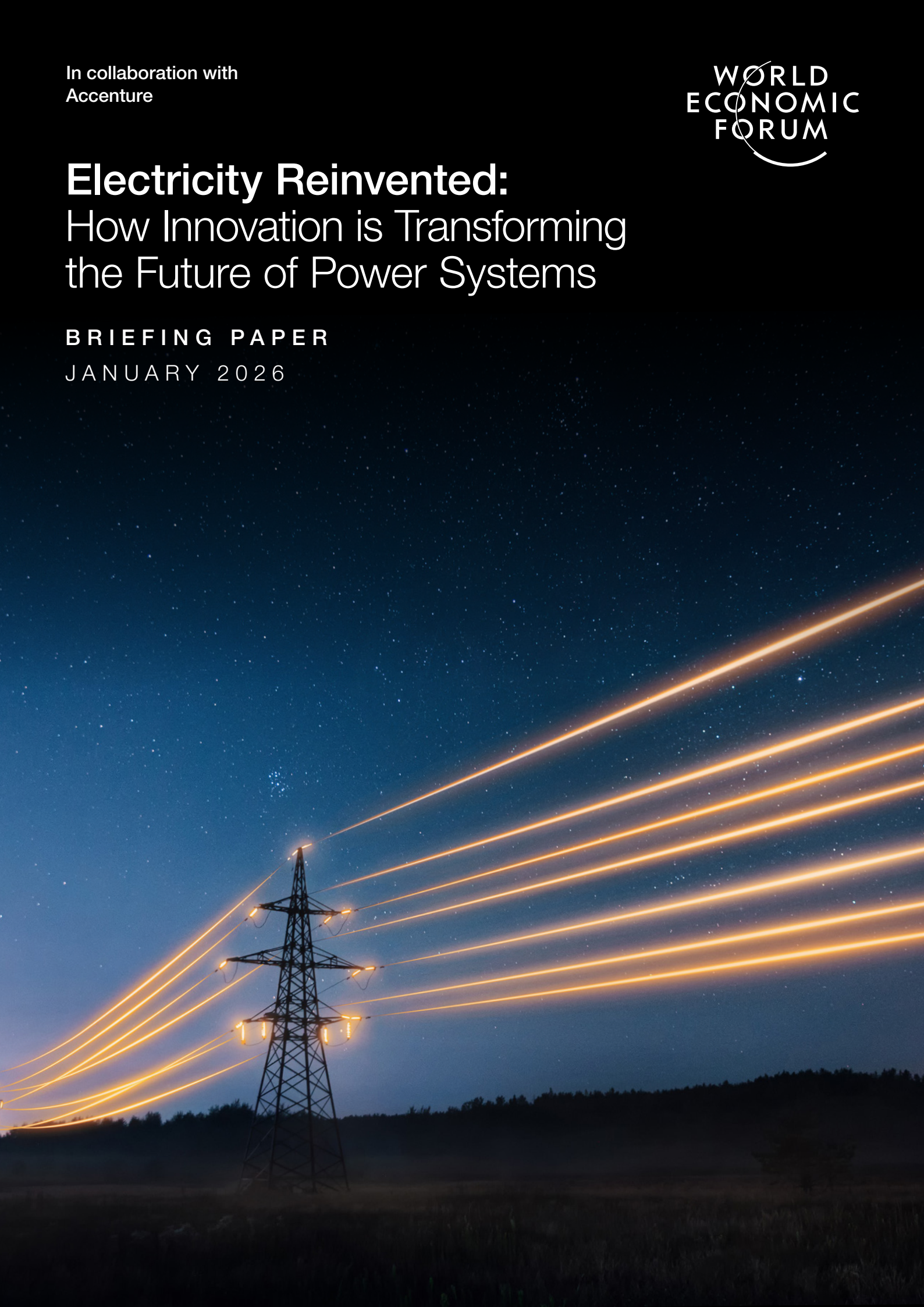
WORLD ECONOMIC FORUM

Electricity Reinvented:
How Innovation is Transforming the Future of Power Systems

BRIEFING PAPER

JANUARY 2026



Images: Getty Images

Contents

This briefing paper is a short primer for the *Innovation Playbook for Future Power Systems*, launched at the World Economic Forum's Annual Meeting in Davos-Klosters in January 2026. The paper highlights key insights and trends for both Annual Meeting participants and a broader global audience.

Introduction

Global energy investment is set to reach $3.3 trillion in 2025, with about $2.2 trillion directed towards renewables, nuclear, grids, storage and electrification – twice the amount invested in fossil fuels.

The transformation of electric power systems is accelerating across the world. Electricity demand is growing at twice the pace of overall energy demand, driven by the electrification of industry and transport, rapid expansion of data centres, heating, cooling and broader digitalization. In 2024, global energy demand grew by 2.2%, while electricity use increased by 4.3%, outpacing both historical trends and global GDP growth.[1]

By 2035, electricity demand is likely to rise to about 37,800 terawatt-hours – a 40% increase from today.[2] Investment trends reflect this shift: global energy investment is set to reach $3.3 trillion in 2025, with about $2.2 trillion directed towards renewables, nuclear, grids, storage and electrification – twice the amount invested in fossil fuels.[3] Electrification has become a core driver of economic competitiveness, making modern power systems central to energy security and sustainable growth.

Power systems encompass how electricity is generated, transmitted, distributed and used – from power plants and grids to demand and flexibility mechanisms. Looking ahead, power systems will need to integrate much larger volumes of clean energy from intermittent sources, expand affordable access and operate in increasingly digital and interconnected ways. They will also need to manage new types of loads – including very large data centres, often exceeding a gigawatt – and strengthen resilience to emerging climate and cyber threats. Addressing these challenges requires new approaches to system planning and regulation, grid management and security.

Innovation is the engine of power system transformation. It brings together clean technologies, digital tools and new business models that improve system performance and unlock value. Many solutions are already available and the next phase of progress depends on scaling-up proven approaches and applying them more widely. The speed at which these innovations are deployed and the extent to which they reduce cost and improve reliability will shape how quickly cleaner and more resilient power systems emerge.

Many effective solutions are systemic, requiring integrated planning that aligns demand growth, grid expansion, digital optimization and multi-energy developments. Realizing this system value depends on coherent market, regulatory and policy frameworks, supported by consistent governance and coordinated public-private investment.

This briefing paper accompanies the *Innovation Playbook for Future Power Systems*, developed by the World Economic Forum in collaboration with Accenture. The Playbook showcases practical, scalable innovations delivering system value across diverse contexts. It is designed to provide a platform for sharing solutions to help decision-makers identify those suited to their market conditions and system needs – supporting the transition to more flexible, resilient and secure power systems for a highly electrified and decarbonized economy.

1 Redefining power systems through innovation

> How power systems are financed, regulated, managed and scaled-up will determine their performance and value to society.

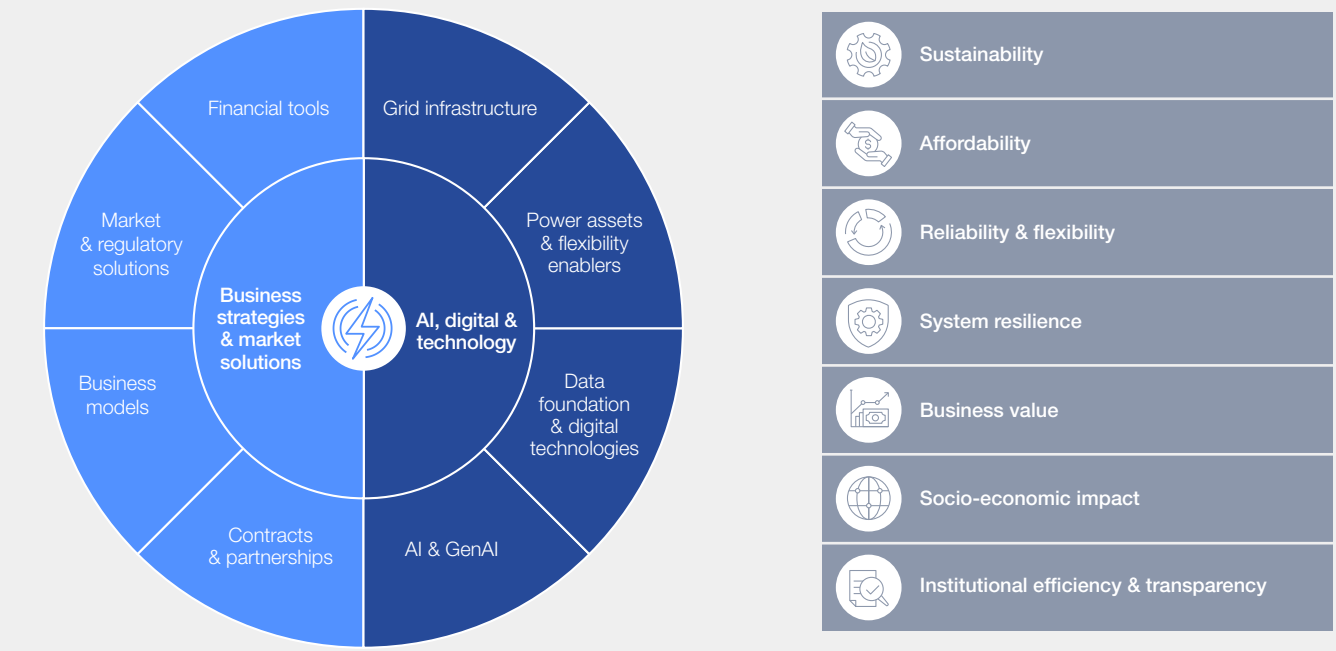
Innovation is a key enabler of power system transformation – but technological advances alone will not suffice. How power systems are financed, regulated, managed and scaled-up will determine their performance and value to society. Innovation today is not linear: technologies evolve, combine and converge – and, when supported by effective policy and finance, can create new business opportunities and systemic value.

In this briefing, innovative solutions are organized by two broad categories:

- **AI, digital and technological innovations** are strengthening power systems end-to-end. Emerging AI applications – from generative (GenAI) and agent-based models to predictive maintenance – are improving planning, forecasting, operations and threat detection. Demand-side innovation, including flexible industrial loads, AI-driven energy management and behind-the-meter optimization, are becoming as important as supply-side advances in shaping system performance. On the grid side, advanced optimization methods, including quantum optimal power flow, are enhancing network decisions, while new digital tools support faster fault detection and improve resilience.
- **Business strategies and market innovations** are accelerating the deployment and scale-up of these technologies. New contract structures, partnerships and business models are redefining how value is created and shared across the ecosystem. Market solutions, financial tools and regulatory innovation mobilize capital, reduce investment risk, strengthen project bankability and reward flexibility, often determining whether proven technologies scale up. Common standards and protocols allow distributed assets and digital tools to integrate seamlessly. Business strategies extend to supply chain resilience through strategic sourcing and contracting models that manage price volatility and support reliable delivery.

For additional details, please refer to the Appendix.

FIGURE 1 **Innovation in future power systems**



Source: World Economic Forum.

2 Unlocking system and business value through innovation

Power systems will need to build trust, inclusion and enduring value.

Innovation plays a critical role in accelerating the transition to cleaner and more resilient power systems. Its impact can be assessed across seven interlinked outcomes: sustainability, affordability, reliability and flexibility, system resilience, business value, socio-economic impact, institutional efficiency and transparency (see Table 1).

Innovations that strengthen system performance enable power systems to meet rising energy demand, improve planning and predictability, optimize operations and integrate new generation and storage while capturing the full value of flexibility. At the same time, power systems will need to build trust, inclusion and enduring value. Business growth, socio-economic benefit and efficient institutions are essential to scale up innovation, attract investment and sustain confidence among governments, investors and consumers.

Together, these outcomes capture the spectrum of value that innovation brings – enabling technical progress, economic opportunity and social benefit that define the power systems of the future.

TABLE 1 | **Innovation outcomes for future power systems**

Outcomes for power systems	Outcome description	Example of innovation contributions
Sustainability 	Accelerates decarbonization by integrating renewables, cutting emissions and improving resource efficiency.	– Integration of renewables (solar, wind, hydro) – Energy efficiency solutions – Circular design and resource optimization – Low-carbon fuels and electrification
Affordability 	Reduces costs for both system and consumers through efficiency gains and smarter asset use, making the transition cost-effective.	– Operational and capital cost reduction – Lower consumer bills – Asset optimization and life-extension – Reduced reliance on subsidies
Reliability and flexibility 	Maintains a secure and stable supply while adapting to variability from renewables and new demand sources.	– Accurate forecasting and scheduling – Automation and system flexibility – Frequency and voltage stabilization – Integration of "prosumers" and distributed resources[4]
System resilience 	Strengthens the system's capacity to withstand and recover from extreme weather, physical disruptions and cybersecurity incidents.	– Backup capacity and emergency response – Climate adaptation measures – Cybersecurity and data protection – Trusted digital platforms ensuring data integrity and auditability
Business value 	Creates incentives for investment and clean electricity use and commercial adaptation by demonstrating competitive advantage and long-term returns.	– Bankable business models – Scalable private sector participation – Investor confidence and ROI – Price signals and competitive advantage for adopters
Socio-economic impact 	Ensures a just and inclusive transition by creating jobs, supporting communities and expanding equitable access to energy.	– Job creation, upskilling and workforce safety – Universal energy access – Community engagement and local economic development – Fair participation of stakeholders
Institutional efficiency and transparency 	Builds efficient, transparent and trusted frameworks that align innovation with effective governance and stable policy.	– Transparent pricing and market signals – Clear permitting and approval processes – Supportive market design and rules – Stable, clear and visible policies for investors' confidence – Institutional capacity and regulatory trust

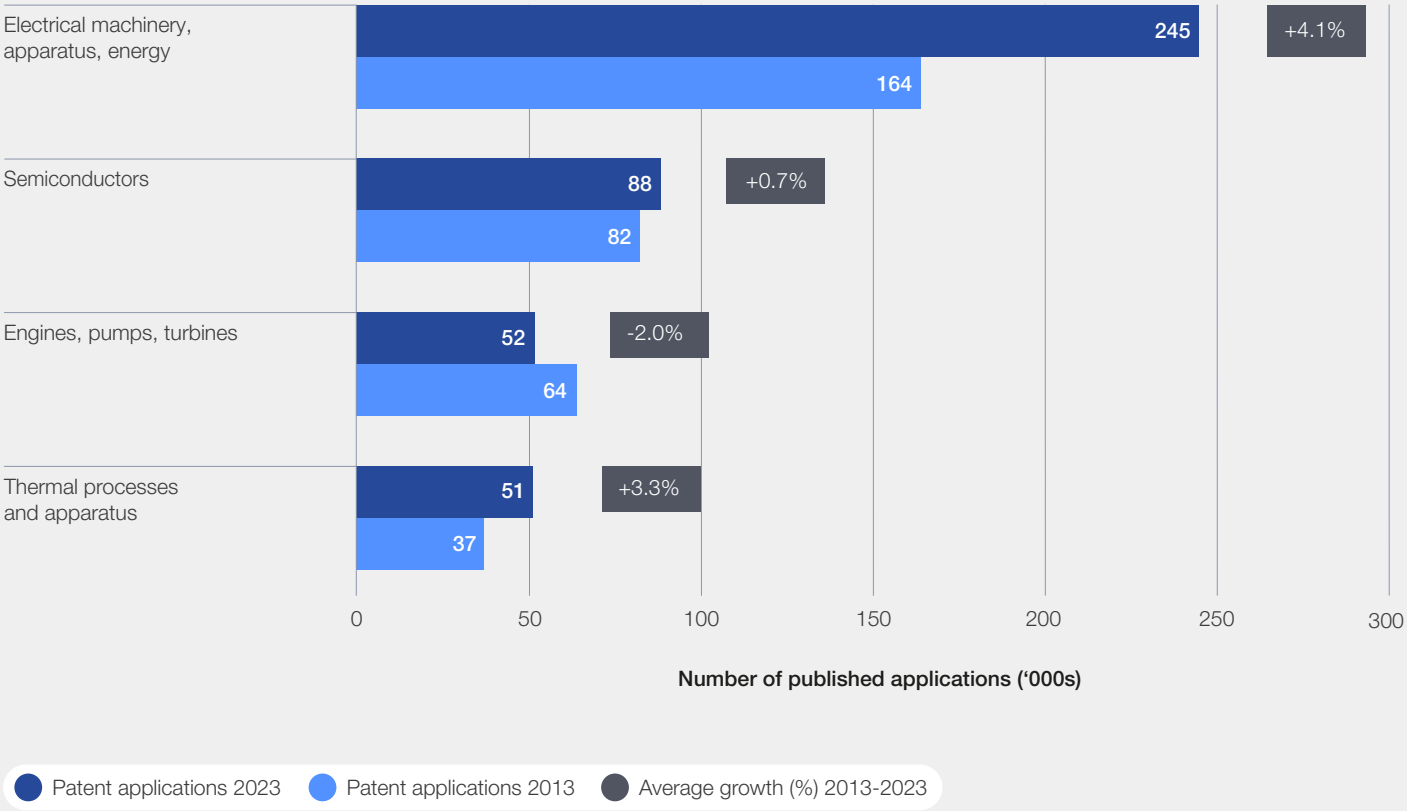
3 Global innovation trends in power systems

Intellectual property and investment data confirm that digital integration and electrification now anchor the energy transition.

While regional pathways may differ by market structure, resource availability and policy priorities, global trends show accelerating power system innovation. Intellectual property and investment data confirm this momentum: digital integration and electrification now anchor the energy transition.

The World Intellectual Property Organization (WIPO) reported strong growth in energy technology patents from 2008 to 2023, with solar rising steadily and wind more than doubling. Fuel cells have declined, while geothermal and hydropower remain small and stable.[5] The International Energy Agency (IEA) reported a similar pattern in investment, with clean energy spending outpacing fossil fuels.[6] WIPO also highlighted a sharp rise in energy-related technology patents between 2013 and 2023 (see Figure 2),[7] alongside nearly 80% annual growth in generative AI applications for energy management between 2018 and 2023.[8]

FIGURE 2 **Published patent applications by field of technology (2013 and 2023)**



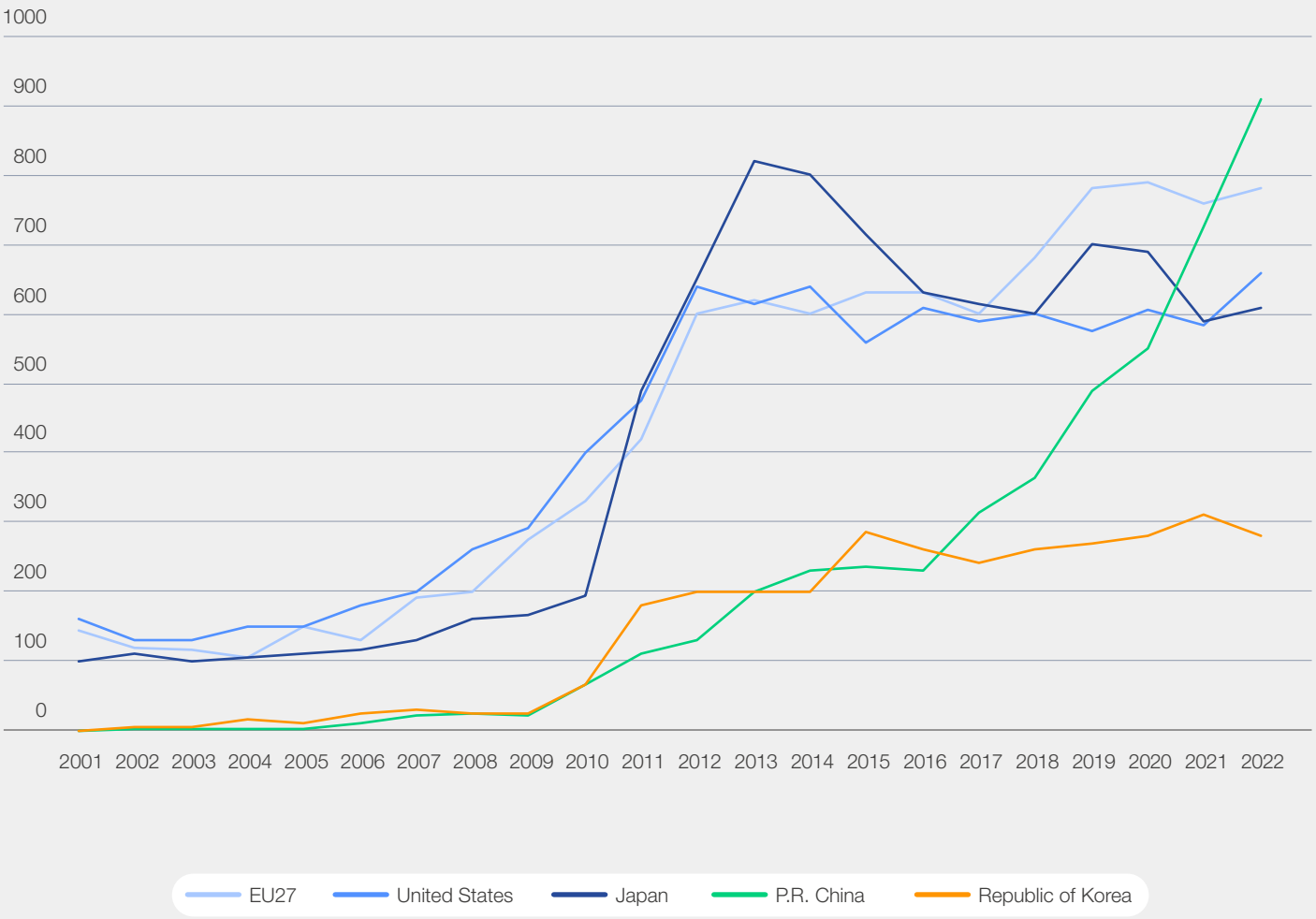
Source: World Intellectual Property Organization, 2025.

4 Regional pathways

Regional innovation patterns reflect distinct system needs, policy priorities and development pathways, shaping how each market transitions. Despite variations at country and sub-national level, distinct innovation trends are visible across regions.

Patent data highlights regional differences in innovation focus. China has emerged as the fastest-growing source of grid-related patents, while activity in the European Union (EU), United States (US) and Japan remains strong but relatively stable (see Figure 3). Recent growth is concentrated in AI-enabled technologies – particularly forecasting, microgrids and outage management – signalling a shift from hardware-led innovation towards digital, data-driven system management (see Figure 4).[9]

FIGURE 3 **Patenting trends, by global regions (IPFs, 2001-2022)**

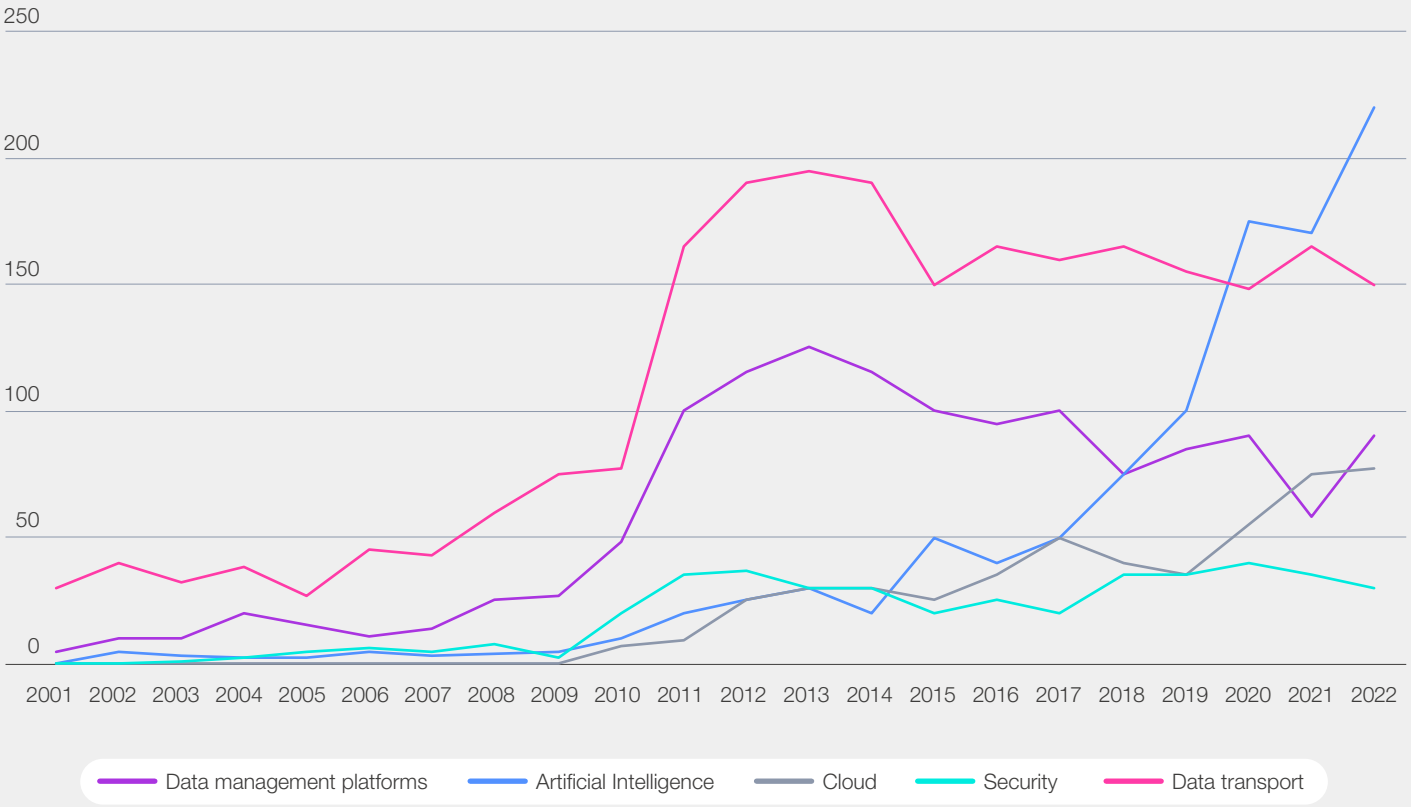


Note: IPF = international patent family.

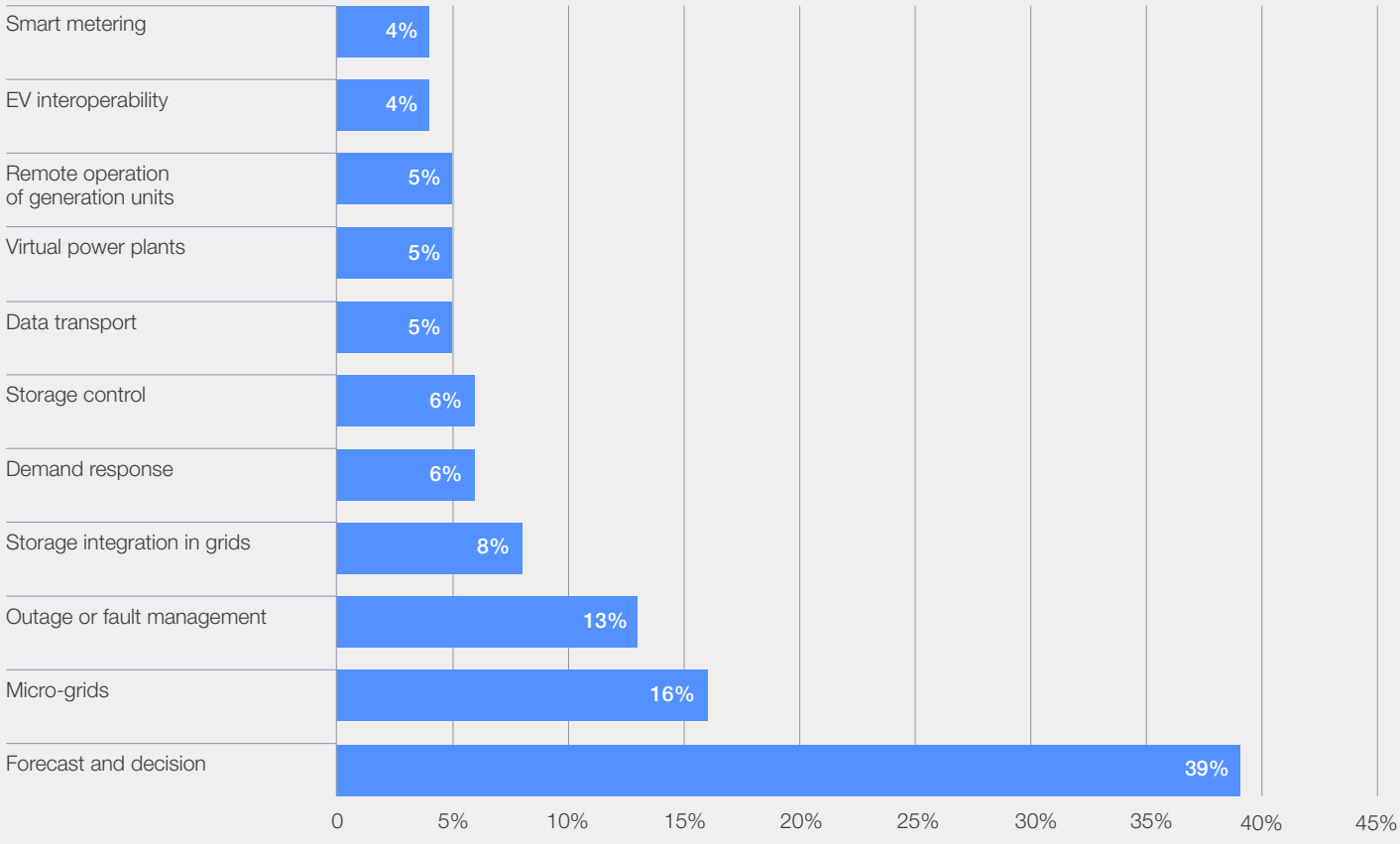
Sources: International Energy Agency (IEA) and European Patent Office (EPO), 2024.

FIGURE 4 | **The growing impact of AI on innovation in smart grids**

Patenting trends in selected enabling technologies for smart grids (IPFs, 2001-2022)



Smart-grid technologies targeted by AI-related IPFs (2011-2022)



Sources: International Energy Agency (IEA) and European Patent Office (EPO), 2024.

> The US leads global grid and storage investment – yet expansion faces planning and permitting bottlenecks, while extreme weather continues to test system resilience.

> High energy costs in Europe – two to five times higher than in the US or China – remain a major concern and faster electrification is essential for competitiveness and climate goals.

> In China, ultra-high-voltage transmission, advanced power electronics, digital grid management and AI-based diagnostics support rapid renewable deployment.

North America: innovation in digital intelligence and grid resilience

North America's electricity growth is accelerating, supported by evolving market structures and price signals that reward flexibility and efficiency. In 2024, US non-fossil generation rose with 50 GW of new solar capacity.[10] The US Department of Energy is also investing in small modular reactors (SMRs).[11] In Mexico, clean energy reached 25% of total generation in 2024.[12] Canada's largely decarbonized system, anchored by hydropower and nuclear, continues to advance climate goals through national carbon pricing.[13]

Ageing grid infrastructure and limited integration capacity remain major constraints.[14] The US leads global grid and storage investment[15] – yet expansion faces planning and permitting bottlenecks, while extreme weather continues to test system resilience.[16,17] In Mexico, drought has pushed hydropower to a two-decade low. [18] Rapid growth in data centres – expected to reach between 6.7% and 12% of total US electricity use by 2028[19] – and rising industrial demand are outpacing infrastructure readiness, making grid access, speed and power costs decisive in siting decisions.

Innovation is increasingly centred on digital grid intelligence. Utilities are deploying AI-driven forecasting, dynamic line rating and digital twins to optimize capacity and anticipate disruption. Satellite monitoring strengthens vegetation management and wildfire preparedness. Dynamic line-rating pilots in the Midwest show how these tools can expand transmission without major upgrades. Heat reuse technologies in modular data centres are emerging business model innovations. A recent RMI study shows that virtual power plants (VPPs) – aggregating batteries, EVs and smart thermostats – could meet over 20% of US peak demand by 2030.[20]

Together, these advances are shifting North America's ageing network towards a more adaptive, data-driven system able to absorb climate and demand shocks. Looking ahead, AI-enabled grid management, data centre integration and industrial heat reuse are likely to underpin more digital, self-balancing power systems.

Europe: innovation for flexibility and competitiveness

Europe has one of the world's cleanest power systems, supported by interconnections, carbon pricing and coordinated policy. Russia's invasion of Ukraine accelerated fossil fuel diversification and investment in renewables and efficiency. North Sea offshore wind now accounts for 35% of global installations.[21] Europe's investment in energy efficiency and end use in 2025 is among the highest globally.[22] Regulatory reforms aim to streamline permitting, ease interconnections and update pricing, although progress remains slow. The EU's updated market design seeks to improve resilience and lower prices by strengthening long-term contracts, increasing transparency and rewarding flexibility.[23]

Renewable growth is creating grid-balancing and pricing challenges, as generation and demand increasingly diverge. Congestion-driven price gaps between Southern and Northern Europe have widened, while curtailment and negative-price hours are rising, especially in Germany, the UK and Ireland.[24] High energy costs in Europe – two to five times higher than in the US or China – remain a major concern and faster electrification is essential for competitiveness and climate goals.[25]

Addressing these pressures requires innovation in AI and GenAI, data foundations, market design, regulation and finance. Smart pricing, AI-enabled grid management and flexible tariffs can narrow the electricity-gas cost gap. Incentives, tax measures and simplified funding access can attract private capital, especially for small and medium enterprises (SMEs). Digitalization, predictive analytics and advanced applications such as digital twins can optimize industrial electricity use and reduce waste.

Innovation efforts now centre on flexibility, market integration and industrial competitiveness. VPPs,[26] vehicle-to-grid solutions, hybrid renewable storage systems and behind-the-meter storage enhance reliability, resource use and local flexibility. Market and regulatory tools direct investment where it delivers the greatest impact. Together, these innovations are shifting Europe towards system optimization – with greater flexibility, stronger cross-border coordination and deeper industrial electrification to reinforce competitiveness and maintain the continent's role as a global benchmark for integrated clean energy systems.

China: innovation for system integration under the dual carbon goals

China's central role in global clean power growth is driven by its electrification push for energy security and its dual carbon goals of peaking emissions before 2030 and reaching carbon neutrality by 2060. Since 2019, China has accounted for half of all worldwide installations of solar panels, 60% of electric vehicle sales and two-thirds of the growth in global electricity demand.[27] China's investment in renewables was the highest globally in 2025[28] and its grid investment in 2024 accounted for about one-fifth of global spending.[29] The 15th Five-Year Plan targets non-fossil fuels at roughly 25% of primary energy by 2030, with wind and solar capacity above 1,200 GW and 100 GW of storage planned for 2025-2027.[30,31]

In provinces where renewable penetration exceeds 60%, challenges include frequency stability, voltage

> In ASEAN, renewable energy costs remain above global benchmarks in several countries, while high financing costs and limited market liberalization constrain private investment.

> India will drive the biggest surge in global energy demand over the next two decades as its economy and population expand. It is projected to account for 12% of global energy demand by 2050.

support and peak-shaving.[32] The move from feed-in tariffs to auction-based contracts for difference strengthens market alignment but creates short-term investor uncertainty.[33] To maintain stability, approvals for new coal capacity continue,[34] with plants increasingly used as flexible backup as market frameworks evolve to integrate energy, ancillary services and capacity mechanisms.

China's innovation momentum centres on system-scale integration. Ultra-high-voltage transmission, advanced power electronics, digital grid management and AI-based diagnostics support rapid renewable deployment.[35] Cloud-based fault detection reduces downtime, while AI forecasting and digital twins enable 98% accuracy and second-level balancing across large grids. These advances link with emerging market designs as a unified national electricity market grows, supported by digital platforms for green power trading and distributed VPPs.

China is exporting not only technology but a systemic model for large-scale integration of renewables, AI, storage and manufacturing. The next wave of innovation will deepen these linkages and support exportable models for system-wide flexibility and deep decarbonization.

ASEAN: innovation through integration and finance

Electricity demand in South East Asia is set to double by 2040.[36] Governments are raising clean energy targets and introducing policies to speed up renewable deployment. The ASEAN Power Grid could mobilize around $760 billion in generation and transmission investments by 2045,[37] enabling resource sharing and energy security.

Despite this momentum, progress remains uneven. Markets with young fossil fuel fleets and long-term take-or-pay contracts face complex financial transitions. Renewable energy costs remain above global benchmarks in several countries, while high financing costs and limited market liberalization constrain private investment.[38] Project pipelines are slowed by inconsistent regulation and limited feasibility studies. Meanwhile, electricity-access gaps persist in countries such as Myanmar.[39] SMRs are gaining attention as low-carbon alternatives, although public acceptance, financing and deployment timelines remain challenges.

ASEAN's transition reflects both opportunity and constraint: rapid clean energy growth coexists with fossil fuel dependence. Innovation focuses on national priorities – scaling-up renewables, improving grid flexibility and attracting investment – while laying the groundwork for regional integration. The ASEAN Power Grid initiative and Singapore's grid digital twin, which simulates EV, solar and distributed energy integration, show how digital tools enhance planning across borders. Storage, digitalization and AI can add flexibility and reduce the need for major grid expansion, while data centre demand can anchor investment through long-term offtake contracts. Decentralized generation – rooftop solar with storage, smart tariffs and VPP-style aggregation – provides local flexibility aligned with system needs.

Blended finance, labelled bonds and concessional funding are drawing private capital to grids. Long-term investment will depend on policy credibility, regulatory certainty and stronger project preparation. Over time, cross-border integration and digitalized trading could make ASEAN a prototype for interoperable power systems.

India: innovation in digital grids and decentralized access

By mid-2025 India's clean energy – renewables and nuclear – accounted for almost half of total capacity,[40] supported by larger auction volumes, rooftop solar incentives and accelerated hydropower permitting.[41] Clean energy attracts over 80% of power sector investment, making India the world's second-largest growth market for renewables.[42]

India will drive the biggest surge in global energy demand over the next two decades as its economy and population expand. It is projected to account for 12% of global energy demand by 2050.[43] Bottlenecks persist: transmission delays and ecological limits have stranded over 50 GW of renewable capacity;[44] thermal power – still about half of total capacity[45] – remains essential for reliability; deployment of frontier technologies is uneven; and financing conditions lag behind the pace of deployment.

Innovation in India spans digital grid modernization and decentralized energy delivery, although progress varies across the value chain. Transmission utilities are deploying AI and GenAI, along with predictive maintenance systems, remote-controlled substations and cybersecure control centres. At the same time, microgrids, solar systems and energy-as-a-service (EaaS) models are expanding access and resilience at the local level.[46] IoT-enabled solar utilization platforms reflect India's shift towards smarter, self-balancing systems.

Together, these advances are shaping a hybrid ecosystem – centralized in capacity yet decentralized in delivery – where digital infrastructure, adaptive finance and local entrepreneurship drive universal electrification. The next phase of progress will hinge on strengthening grid intelligence, modernizing distribution utilities and scaling-up locally tailored solutions, supported by regulatory reforms that can accelerate adoption.

> In 2023, clean energy made up just over 20% of power sector investment in the Middle East, while transmission and distribution accounted for about 40%.

> Debt service absorbs more than 85% of total energy spending and Africa attracts only around 2% of global clean energy investment despite representing 20% of the world's population.

> Across the advanced Asia and Oceania region, innovation aims to manage high shares of variable renewables while safeguarding reliability.

Advanced Asia and Oceania: innovation for flexibility and decarbonization

Advanced Asia and Oceania – including Australia, Japan, South Korea and New Zealand – focus on system flexibility, reliability and decarbonization, driven by mature systems, high per-capita demand and ambitious net-zero targets. Australia leads in distributed solar and is advancing its National Battery Strategy to make storage central to its clean energy transition.[47] Japan targets 40-50% renewable electricity by 2040 while maintaining nuclear for system stability.[48] South Korea is scaling-up renewables and storage to meet its 2050 net-zero goal, supported by hydrogen and offshore wind strategies.[49]

Across the region, innovation aims to manage high shares of variable renewables while safeguarding reliability. AI-driven forecasting, demand-response platforms and advanced inverter support system balance. In Australia, digital controls and behind-the-meter batteries are transforming households into active grid participants. Japan and South Korea are adopting real-time demand forecasting and flexible market mechanisms to improve system reliability under decarbonization constraints.

As these systems mature further, the region is likely to pioneer digital, storage and hydrogen-based solutions that can demonstrate how high-renewable, fully electrified power systems operate reliably at scale.

Middle East: innovation in using digital to meet demand growth with low-carbon sources

The Middle East faces rising pressure from growing energy demand. Economic growth, population increases and hotter weather are driving up demand for electricity, cooling and desalinated water. Nearly 95% of the region's power still comes from oil and gas – the highest share globally – and demand growth risks pushing fossil fuel use even higher despite exceptional solar resources.[50]

In 2023, clean energy made up just over 20% of power sector investment in the Middle East, while transmission and distribution accounted for about 40%.[51] The UAE and Saudi Arabia are positioning themselves as regional transition leaders with major investments in renewables and low-carbon projects. Both are expanding utility-scale solar and wind and have begun integrating storage to manage intermittency.[52,53] Meanwhile, traditional petrostates such as Kuwait and Qatar are to a larger extent relying on natural gas as their bridge to lower-carbon power.[54,55]

Innovation focuses on digitalization and distributed resources, from AI-enabled forecasting and digital grid management to expanded distributed solar and storage. Blended finance is helping unlock investment in renewable and storage infrastructure. Progress will likely depend on improving grid flexibility, scaling-up digital tools and attracting capital for renewables and storage to manage fast-rising demand and intensifying climate pressure.[56,57]

Africa: innovation in decentralized access and digital planning

Africa's installed power capacity reached 260 GW in 2024, a 2.4% year-on-year increase. Clean energy accounted for 68.8 GW, while fossil fuels – particularly gas – still dominate the power mix, accounting for around three-quarters (190 GW) of total capacity. Coal remains the backbone of electricity generation in South Africa;[58] meanwhile North African systems rely heavily on gas, although solar and wind investment is rising in countries such as Morocco and Egypt. Nuclear offers long-term potential but faces financing and regulatory hurdles.

Energy access remains the overriding priority in Africa: 600 million people still lack electricity and nearly 1 billion lack clean cooking.[59] North African countries have higher access, but affordability, reliability and rural gaps persist. Frequent outages, currency depreciation and high financing costs limit the ability to modernize grids and expand clean energy. Debt service absorbs more than 85% of total energy spending and Africa attracts only around 2% of global clean energy investment despite representing 20% of the world's population.[60]

Innovation is becoming more decentralized and digital. AI and GenAI planning tools map least-cost electrification pathways, while smart metering, digital controls and grid-monitoring systems help cut losses and manage intermittency.[61,62] Mini-grids, distributed solar and hybrid storage systems are expanding across Sub-Saharan and North African countries, supported by blended finance structures that combine concessional and private capital.[63] These approaches are linking digital planning, distributed energy and flexible finance to close access gaps and build more climate-resilient, investor-ready infrastructure.

Looking ahead, progress will depend on scaling-up decentralized solutions, strengthening distribution networks and mobilizing more diverse finance. Digital planning, blended finance and locally tailored energy systems will be critical for building resilient grids and achieving universal electrification.

> Latin America's focus is shifting from adding clean generation to building systems that can reliably integrate it. Grid modernization, digitalization and regulatory upgrades are advancing.

Latin America: innovation in grid modernization and hybrid systems

Latin America has one of the world's cleanest power mixes, with renewables supplying about 69% of electricity, led by hydropower, wind and solar respectively. Reliance on hydropower, transmission bottlenecks and long distances between resource and demand centres create climate-related volatility and curtailment. In 2024, over 50 TWh of renewable generation was lost to congestion – equal to the annual use of more than 10 million households.[64] In Brazil, clean energy resource areas and demand centres remain poorly connected,[65] despite the 2024 transmission auction mobilizing nearly $4 billion to build new lines.[66] In Chile, long north-south distances caused curtailment of about 10% of solar output in 2024.[67]

Latin America's focus is shifting from adding clean generation to building systems that can reliably integrate it. Grid modernization, digitalization and regulatory upgrades are advancing, with countries improving transmission planning, expanding storage and deploying forecasting and control tools. New financial instruments and sustainability standards are also improving project bankability. The next step is regional integration – linking markets, harmonizing regulation and enabling green manufacturing hubs. With digital, interconnected grids, Latin America can turn its clean energy potential into competitive advantage and expand low-carbon exports.

To gain further perspective on these insights, please refer to the Forum's October 2025 report, *Advancing Latin America's Power System Transformation*.[68]

CASE STUDY

Uruguay – innovation through policy alignment

Uruguay demonstrates how coordinated planning, policy and innovation can transform a national power system. In less than two decades, it has shifted to a ~98% renewable electricity mix – primarily biomass, hydro, solar and wind – phasing out fossil fuels that once supplied a third of its power and reducing power costs and prices.[69]

The country's modern grid enables smart-grid applications such as predictive maintenance and real-time optimization. Intelligent metering, automation and data analytics projects are advancing with support from the Inter-American Development Bank. Tax incentives under the Investment Promotion Law are drawing private investment into smart infrastructure and energy storage and complement upcoming green hydrogen and e-fuels projects.[70]

Uruguay's experience – which includes use of capacity auctions and a central role for the system operator – shows that policy design, risk-sharing and system alignment are as important as technology. With regulatory clarity and investment-supporting principles, the country unlocked private capital and quickly scaled-up renewables, creating a cleaner, more reliable and affordable power system that strengthened energy security, competitiveness and jobs.

Although every system has different constraints, Uruguay demonstrates how alignment across policy, planning and investment can create the conditions for innovation to scale up, delivering both climate leadership and commercial advantage, offering lessons that other countries can adapt to accelerate their clean growth while keeping systems resilient and costs manageable.

5 From insights to action

The Forum's *Innovation Playbook for Future Power Systems* is more than a catalogue of solutions – it is a practical resource showing how innovation delivers system-level progress. It combines real-world examples and insights that support planning, operations and financing, highlighting best practices for large-scale renewable integration, greater flexibility, higher efficiency and investment in resilient, digital infrastructure.

The Playbook supports decision-makers across the power system value chain and beyond, by providing an accessible, up-to-date repository of solutions. Users can search, filter and compare innovations by category, outcome or geography to inform strategy, prioritize investment and shape policy. As a living resource, the Playbook is designed to evolve through future editions following its launch, incorporating new use cases and stakeholder insights to ensure that knowledge remains current and actionable.

By linking each use case to tangible outcomes such as affordability, efficiency or reliability, the Playbook enables decision-makers to identify solutions that best fit their needs and development priorities:

- For **system planners and operators**, the Playbook highlights solutions that strengthen forecasting, real-time visibility and grid flexibility.
- For **developers and asset owners**, it showcases technologies and models that improve project integration, interoperability and commercial scalability.
- For **policy-makers and regulators**, it offers evidence on enabling frameworks and tools that align incentives and accelerate deployment.
- For **investors, corporates and financial institutions**, it surfaces context-tested mechanisms and opportunities that enhance bankability, reduce risk and link financial innovation to measurable system value.

The Playbook empowers leaders across the energy ecosystem to make informed decisions, accelerate deployment and unlock system-wide value.

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AES

China Southern Power Grid

Clean Energy Ministerial

Enel

Eolian

Hitachi Energy

Iberdrola

International Energy Agency

Octopus Energy

Schneider Electric

Siemens

World Nuclear Association

Production

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Appendix

Innovation is driving the transformation of power systems towards the future. This briefing paper organizes them under two categories:

- **AI, digital and technological innovation** that modernizes grids, enhances flexibility and enables smarter, data-driven operations.
- **Business strategies and market solutions** innovation that scales these up through business models, partnerships, market and regulatory mechanisms and financing tools.

The table below shows these two main categories and their sub-categories, summarizing how each type of innovation enables the transition towards the future power system, along with examples of practical applications in each sub-category.

Category	Sub-category	Description	**Example** (non-exhaustive)
AI, digital and technology 	**Grid infrastructure**	Solutions enable the modernization of transmission and distribution networks to achieve the integration of an increasing share of renewable and decentralized energy sources.	Dynamic line-rating to increase transmission capacity and value existing assets, avoiding costly upgrades.
	Power assets and flexibility enablers	Solutions enable the optimized use of generation and complementary grid assets to achieve improved reliability and system flexibility, including assets enabling demand response.	Large-scale battery systems to strengthen grid stability and enable more efficient renewable integration.
	Data foundation and digital technologies	Solutions enable secure, real-time system intelligence in order to achieve effective decision-making and efficient renewable integration.	Digital twin grid monitoring to monitor asset health and simulate renewables integration, optimizing maintenance and improving planning accuracy.
	AI and GenAI	Solutions enable intelligent automation across planning and operations to achieve enhanced reliability and optimized resource use.	AI for battery optimization, leveraging forecasting and trading algorithms to maximize revenues and improve dispatch accuracy.
Business strategies and market solutions 	**Contracts and partnerships**	Solutions enable collaborative deployment models across stakeholders in private and public sectors, to achieve faster innovation cycles and reduce project risk.	Transmission system operator (TSO) early framework agreements to streamline procurement and improve investment visibility.
	Business models	Solutions enable the creation of new value streams and services, to achieve a more flexible and customer-centric grid.	All-in-one vehicle-to-grid (V2G) bundle to support grid flexibility during peak demand and optimize user experience and monetization.
	Market and regulatory solutions	Solutions enable the design of incentive structures and pricing mechanisms to achieve greater system flexibility and clean energy integration.	Grid-scale energy storage auctions to drive private investments and expand renewable integration capacity.
	Financial tools	Solutions enable the funding and de-risking of energy projects, to achieve scalable investment and accelerated deployment.	Innovative revenue stabilization contracts for battery storage that de-risk battery investments, by ensuring stable minimum revenues while allowing upside from market opportunities.

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