Deutsche Bank
Chief Investment Office

PERSPECTIVES

Special

June 2026

The new age of electricity

Geopolitics, the role of the state and new technologies

Deutsche Bank
Chief Investment Office

Contents

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01 **Introduction**

02 **Electrification as a geopolitical strategy**

03 **The expanding role of the state in energy systems**

04 **The clean technology power struggle**

05 **It's not all about AI**

06 **Clean technologies, where are we?**

07 **Conclusion**

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01

Introduction

At a fundamental level, energy is defined as the ability to do work. Doing this work involves the transfer of one form of energy into another: for example, the chemical energy in hydrocarbons into the kinetic energy of a moving car.

Electrification helps us do this in ways that are potentially both **less damaging** to the environment and **more resilient** to geopolitical and other tensions around resource use. It allows us not only to increasingly draw on cleaner energy resources such as wind and solar, but also to transport energy easily across geographies as well as types. Use of energy sources such as hydrocarbons – not just environmentally problematic, but also vulnerable to supply disruption – can then be concentrated on those remaining areas where they are not easily substitutable. Electrification, in summary, provides a key bridge between sustainability and more traditional investment drivers, to the potential benefits of populations, policymakers and investors.

In 2025, the world invested USD3.3tn in energy systems according to the IEA (International Energy Agency) with around USD2.2tn flowing into clean energy categories.[1] But what is also striking is that, again according to the IEA estimates, **electricity system investment** was USD1.5tn in 2025, almost 50% higher than investment in fossil fuel supply. In the emerging "electricity super cycle", electricity demand and investment is growing faster than overall energy demand as end-users shift from direct fossil fuel combustion towards electrified alternatives, a trend we have discussed in previous **reports**. Europe provides a particularly striking illustration of this dynamic: here clean energy supply investment exceeds fossil fuel supply investment by a factor of 3.5 to 1.[2]

The process of electrification is ongoing and funding gaps remain. The IEA highlights that **global grid investment** needs to rise sharply towards parity with generation investment, to ensure power systems can absorb and integrate rapidly rising shares of renewables. In addition, the **distribution of investment remains uneven.** Africa, home to around 20% of the global population, receives only about 2% of clean energy investment.

Nonetheless, there have already been fundamental shifts in the **electricity supply mix**. Renewables are projected to overtake coal as the largest source of global electricity generation by mid-2026.[3] In China coal still accounts for roughly 60% of generation but low-carbon sources now provide close to one third of electricity, and virtually all net growth in electricity demand will be met by renewables, led by solar, wind and hydro.[4] In the EU (European Union) wind and solar delivered 30% of electricity generation in 2025, surpassing fossil fuels (29%) for the first time.[5] In the US, progress has however been slower in the past years and more politically contingent: natural gas accounts for around 40% of generation, renewables 22%-23%, and nuclear close to 18%.

Rapid growth in renewables capacity is likely to continue. The IEA expects that between 2025 and 2030, installed renewable power capacity will double. By 2030, around half of global electricity generation is expected to come from renewables and nuclear combined, a level of low-carbon penetration that until recently was viewed as a long-term aspiration rather than a near-term outcome.[6]

In the years to 2030, **electricity demand** is projected to grow roughly 2.5 times faster than total final energy demand, according to the IEA, due to electrification in industry, electric vehicles, buildings, space cooling and, increasingly, data centres. **Global EV sales** reached 26% of passenger vehicle sales in 2025, up from 21.7% in 2024[7] and recent geopolitical shocks and their effect on gas prices are now providing an additional tailwind, as discussed later in the report.

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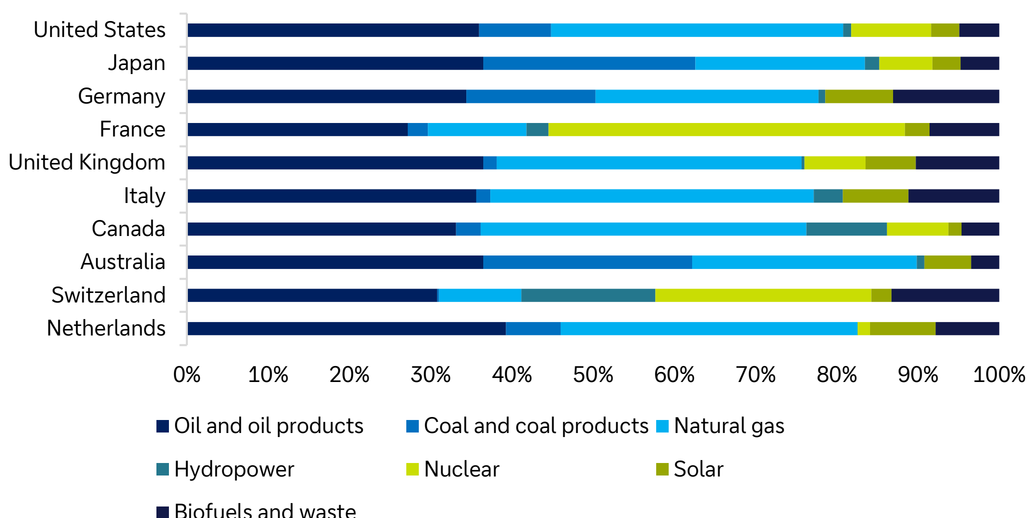
The energy transition is now being driven increasingly by **hard economics** rather than climate policy alone. Industry analysis indicates that solar PV paired with battery storage is already cost-competitive with coal and gas in several markets.[8] **In summary, clean power has already moved from a subsidised niche to mainstream investment logic.**

Figure 1: Energy mix across the main developed economies

Total energy supply for G10 countries, by source, 2024



Source IEA, Deutsche Bank AG. Data as of April 2026.

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02

Electrification as a geopolitical strategy

Recent conflicts have reminded us of the intrinsic mismatch between fossil fuel dependence and energy security in an increasingly fragmented world. As a result, there has been considerable discussion of how **energy policy** will increasingly be shaped by strategic exposure to geography, supply routes, political risk and cost optimisation, complementing nation states' environmentally-conscious decarbonisation objectives.

Fossil fuels differ from renewables in three geopolitically-relevant dimensions. First, as widely known, reserves are **geographically concentrated**. Second, **consumption depends on physical transport** via pipelines and shipping lanes. Third, as clearly shown by the Iran conflict, global supply is exposed to a limited number of **critical chokepoints (e.g. the Strait of Hormuz).** Some regions are more exposed to these chokepoints than others. According to the US Energy Information Administration and the International Energy Agency, oil and LNG shipments through the Strait of Hormuz in 2025 continued to be overwhelmingly directed toward Asian markets, with around 80% of crude oil flows and the vast majority of LNG destined for Asia.[9]

Expanding fossil supply does not eliminate this vulnerability: it merely shifts exposure across routes and suppliers, reducing but not removing chokepoint risk.

In the discussions around energy policy, a distinction is increasingly being drawn between economies that are dependent on importing fossil fuels but are structurally electrifying (so-called **electrostates**) and those that remain reliant on the direct combustion of fuels (**petrostates**).

An electrostate is defined by a **rising share of total final energy consumption delivered as electricity** rather than through direct combustion of fuels. In this sense, electrification converts energy from a traded geopolitical commodity into a domestically produced infrastructure service. China represents the clearest example of this model. China remains highly exposed to imported oil and gas but this exposure has reinforced, rather than weakened, its commitment to electrification and domestic clean-energy buildout.

For electrostates, electrification involving renewables appears to be the most rational economic strategy, both in terms of cost competitiveness and economic resilience when hydrocarbons supplies are disrupted, at least in terms of price volatility.[10] But while high renewables capacity may reduce volatility, it does not translate directly into lower costs of electricity: much will depend on how the country's **wholesale electricity market** works, which vary widely across countries in their design and regulatory objectives, and these differences materially affect how renewables translate into costs. Unlike fossil fuels, which are priced globally, electricity prices are local and shaped by national market rules, grid constraints and institutional choices.

In liberalised systems, marginal pricing tends to lower average prices as renewable penetration rises but also increases volatility and compresses producer revenues during periods of high wind and solar output. This has led many countries to complement markets with contracts for difference, capacity mechanisms or regulated remuneration to sustain investment. More state-coordinated systems rely instead on long-term contracts or administered pricing, reducing volatility and financing costs, but often shifting risks onto public balance sheets and weakening real-time price signals.

As a result, high renewable penetration does not automatically imply lower electricity costs. Outcomes depend critically on **market design**, **transmission infrastructure** and how **balancing** and **flexibility** costs are allocated, making national wholesale markets a key determinant of the economic value of electrification.

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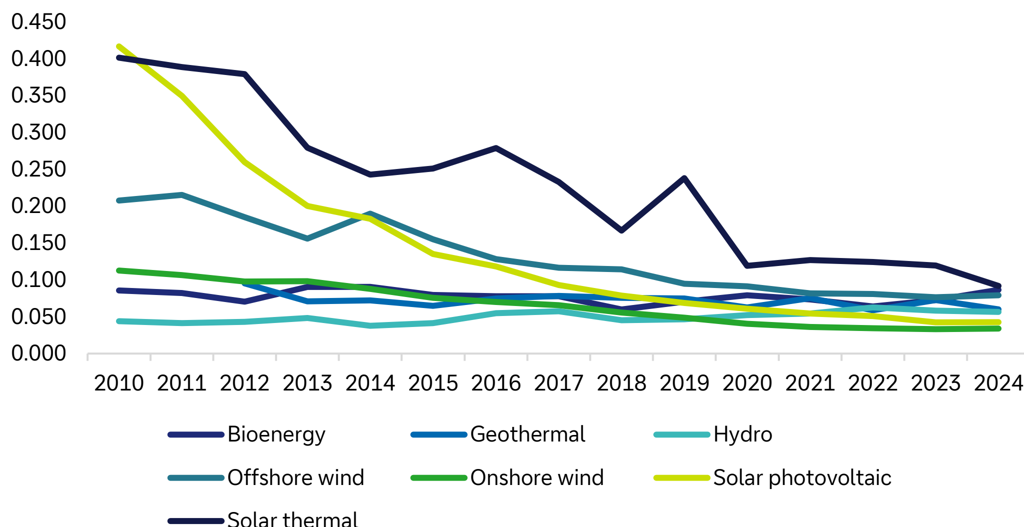
These structural differences help explain why energy security gains from electrification are neither immediate nor linear – and why geopolitical shocks can also still produce **short-term reversals**. After the start of the Iran war, for example, several Asian economies increased coal usage as LNG prices surged and gas supplies tightened.

In the energy transition, therefore, a desire for energy security is for the moment playing a larger role than the desire to reduce carbon emissions. But energy security gains from electrification are not automatic; they depend on infrastructure, system resilience, and the ability to mobilise capital at scale. This shifts attention from fuels to networks, and from markets to institutions. **The energy transition is increasingly mediated by individual countries' industrial policies, whether explicitly acknowledged or not**.

Figure 2: The renewable levelized cost of energy decline



Source: IRENA, Deutsche Bank AG. Data as of April 2026.

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03

The expanding role of the state in energy systems

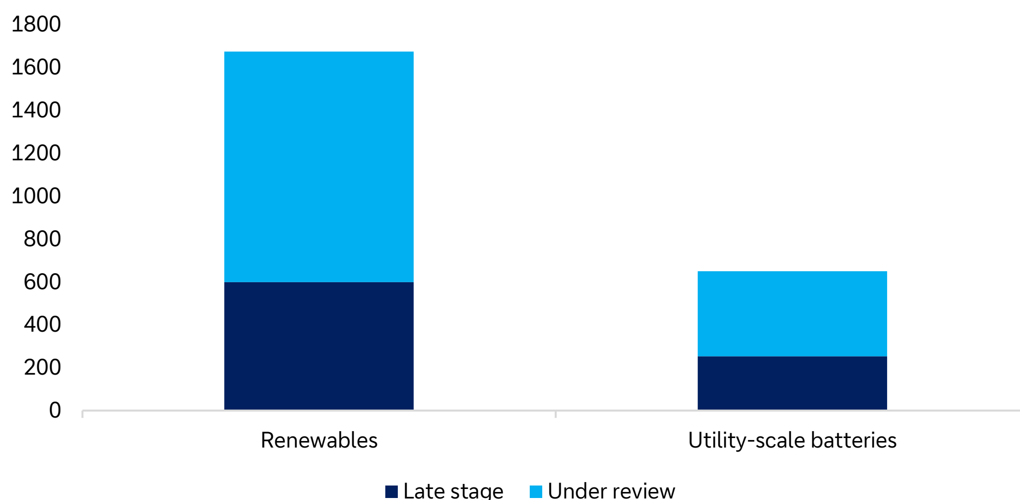
As energy systems shift from fuels to networks, the centre of gravity moves towards infrastructure, supply chains and system resilience. This has brought governments and public authorities back into a more active role – not as substitutes for markets, but as coordinators of systems characterised by long investment cycles, network effects and strategic dependencies.

Many major economies are now placing greater emphasis on **nearshoring** and **friendshoring** to strengthen the security of their electrification supply chains. This involves relocating or diversifying manufacturing and materials processing to regions either in close proximity or among trusted geopolitical partners. By reducing dependence on external suppliers, countries aim to **minimise exposure** to critical chokepoints, shipping disruptions and unpredictable policy shifts

Such adjustments, however, can **reshape cost structures**, since production closer to home may sacrifice some economies of scale. This trade-off requires active industrial policy interventions – for example, incentives and strategic partnerships – to balance resilience goals with cost competitiveness. Two constraints now define this phase of the energy transition. The first is physical and infrastructure based: grids, interconnectors and storage increasingly determine how much clean generation can be absorbed by the system. The second is industrial and resource based: electrification reduces exposure to imported fuels but increases reliance on a concentrated set of critical materials embedded in generation, storage and networks. Addressing these constraints has become a central objective of energy and industrial policy across major economies.

BloombergNEF estimates that USD15.8tn of **global grid investment** will be required between now and 2050 under its base-case energy transition scenario. The majority of this investment will be directed towards physical assets such as transmission lines, substations and distribution networks, amounting to an expansion of approximately 29 million kilometres of grid infrastructure.[11]

Figure 3: Grids investments acceleration is needed to avoid bottlenecks.



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However, the IEA notes that while spending on renewable generation has nearly doubled since 2010, global grid investment has remained broadly flat at around USD300bn per year. To meet climate and energy-security objectives, it reckons that grid investment must nearly double to more than USD600bn annually by 2030, with a strong emphasis on modernising and digitalising distribution networks.[12]

The urgency of this challenge remains underappreciated, even though underinvestment has already translated into tangible **system bottlenecks**. Globally, the IEA estimates that at least 3,000 GW of renewable projects – including around 1,500 GW at advanced stages of development – are currently waiting in grid connection queues. This is equivalent to roughly five times the amount of solar and wind capacity added worldwide in 2022.[13]

Europe provides a clear illustration of the costs of this**. Congestion-management costs** in Europe approached EUR9bn in 2024, while 72 TWh of predominantly renewable electricity was curtailed due to bottlenecks – roughly equivalent to Austria's annual electricity consumption.[14]

Electrification in the US has different drivers. Historically, it has advanced unevenly and has often been driven by concentrated sources of demand rather than a unified national security imperative. This remains the case now: BloombergNEF estimates that more than 80% of new US power capacity added in 2025 – across solar, wind and storage – was driven by **corporate demand from data centres**, particularly those linked to AI workloads. Rapidly rising expectations for data-centre electricity demand is placing increasing strain on local grids and transmission infrastructure and grid investment in the US has begun to respond, rising by 9.5% to USD115bn in 2025, but remains insufficient relative to system needs.[15] As of end-2024, more than 10,300 projects representing approximately 1,400 GW of generation capacity and 890 GW of storage capacity were seeking grid interconnection in the United States.[16]

As electrification becomes infrastructure-led, it also becomes more materials-intensive. Clean energy technologies and electricity networks rely on large volumes of **critical minerals** – including copper, aluminium, lithium, cobalt and nickel – used across wind turbines, solar panels, batteries, power electronics and grids). Between 2023 and 2024, global demand for lithium rose by nearly 30%, while demand for nickel, cobalt and graphite increased by 6-8%. Under current policy trajectories, demand for critical minerals could double by 2030.[17]

Supply chains for critical minerals are geographically concentrated and, in several cases, dominated by a small number of countries. China hosts about 92% of global rare earth refining capacity and around 77% of cobalt refining, underscoring the new strategic exposure.

Electrification can thus **trade fuel dependence for other materials dependence**: it cuts oil and gas imports but increases reliance on traded minerals embedded in energy infrastructure. This realisation has prompted a wave of US state intervention, using existing legislation, public funding for loans and grants and acquisition of stakes in rare earth miners and processors**.** Critical minerals are now viewed as strategic assets.

Taken together, these pressures explain the expanding role of the state in electrification. Grid expansion, storage deployment and critical-material strategies are increasingly treated as matters of national interest rather than purely commercial decisions.[18] Energy policy increasingly overlaps with industrial policy and how to gain economic advantage. **Energy transition therefore becomes an important aspect of national strategic competition**.

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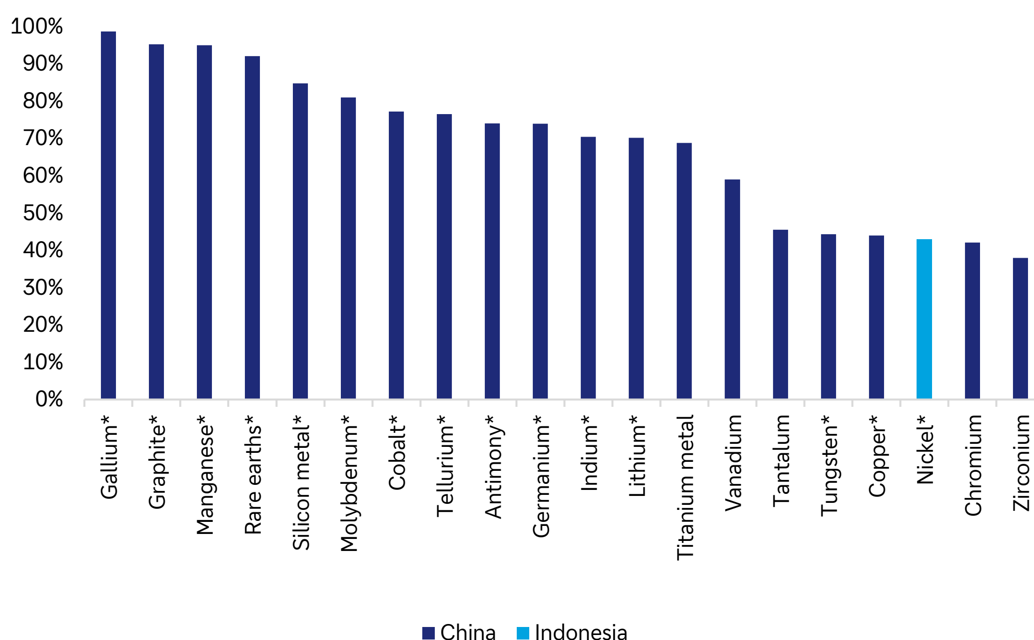
Figure 4: Share of top refining country for 20 energy-related minerals/materials over global supply



* Included in the EU list of Critical Raw Materials (CRMs).

Source: IEA, Deutsche Bank AG. Data as of April 2026.

04

The clean technology power struggle

Across many industrial metrics relevant to **clean energy hardware** – including manufacturing scale, cost, supply-chain integration and export capacity – **China** has established a position of relative strength, particularly in manufacturing-intensive segments.

For example, according to the IEA, China controls more than 90% of global rare earths separation and refining output[19] and 94% of the global production of sintered permanent magnets[20] (essential for electric vehicle motors and wind turbines).

Solar illustrates several of the drivers behind China's strong position. In 2024–25, China dominated global solar PV manufacturing capacity[21] across the entire value chain, a position that has persisted into 2026, while employing around 2.4 million people in the solar manufacturing sector.[22] A highly integrated solar industrial ecosystem spanning polysilicon, wafers, cells, modules, inverters and balance-of-plant equipment is supported by a large and fast-growing domestic market. Scale and coordination, rather than labour costs alone, have underpinned this outcome.[23]

China's position in **global battery manufacturing** has shown similar dynamics. Over time, production scale, vertically-integrated supply chains and rapid learning rates have translated into lower costs. Lithium iron phosphate chemistries, suitable for mass-market vehicles and stationary storage, have gained particular traction and now account for a large share of domestic battery deployment, with further growth expected. These developments have supported China's competitiveness across related EV, storage and grid-equipment value chains.

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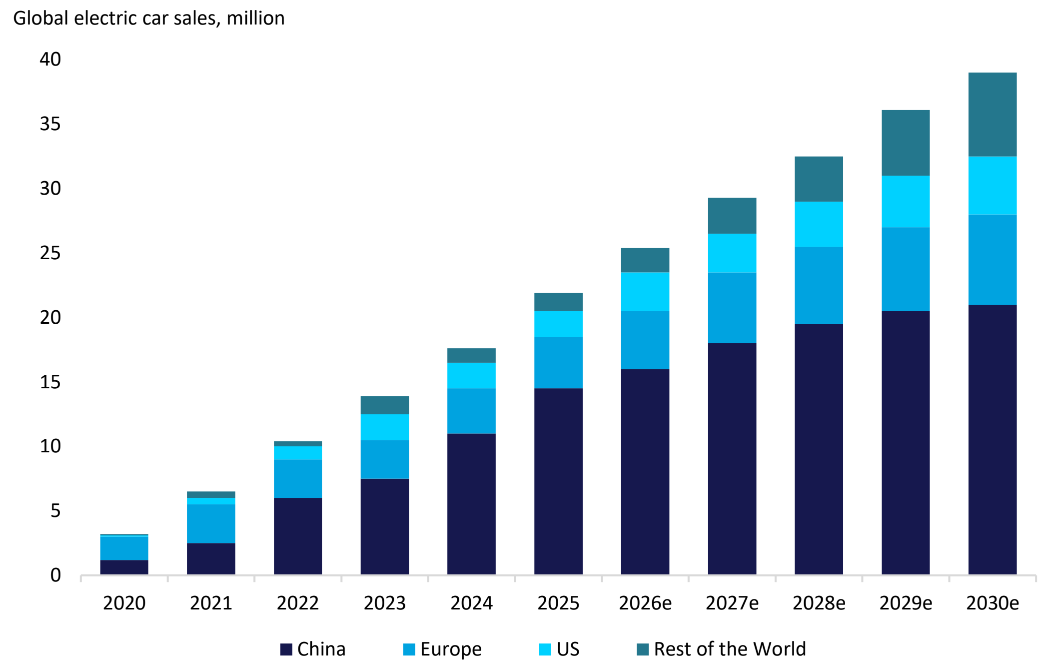
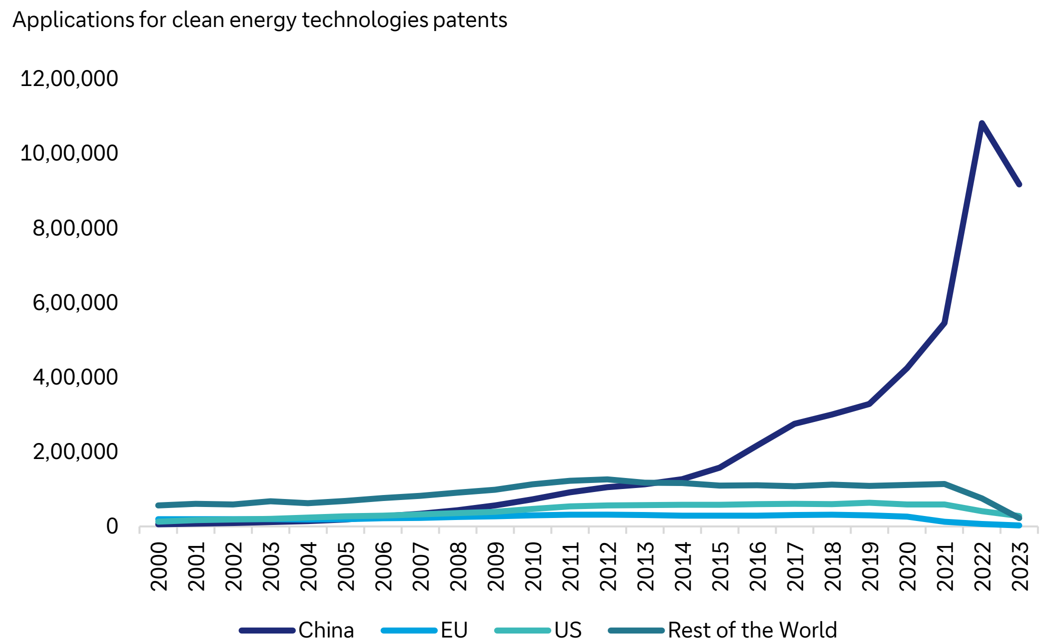
Figure 5: Growth in EV Sales across the world and China's share



Source: BloombergNEF, Deutsche Bank AG. Data as of April 2026.

Figure 6: Patent surge cements China's clean tech dominance



Source: IRENA patent database, Deutsche Bank AG. Data as of April 2026.

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In the **automotive** sector, China's rise to be a leading global exporter reflects improvements in product quality, cost competitiveness and supply-chain control, rather than a simple displacement of incumbent manufacturers. It remains subject however to trade policy, regulatory and consumer-preference constraints.

The contrasting fortunes of China and European clean energy sectors partly reflects different **financing and policy frameworks**. China has relied more heavily on state balance sheets, policy-directed credit and industrial coordination to support scale-up, accepting periods of overcapacity and margin compression. Western clean tech has been more exposed to public capital markets, producing different risk-reward profiles rather than a simple divergence in technological capability.

China's strategy has however increased the country's exposure to external trade frictions and to the economic costs associated with sustained overcapacity. In this sense, China's approach reflects a deliberate trade-off between industrial positioning and financial efficiency.

China's export successes are linked to a broader shift in China's trade profile towards **knowledge-intensive services**. According to World Trade Organization data, China has risen to become the world's sixth-largest exporter of digitally-delivered services, up from 17th place in 2005. Overseas infrastructure projects linked to the Belt and Road Initiative typically extend beyond initial construction, with Chinese firms securing multi-year service agreements covering operations management, digital monitoring, maintenance and system upgrades.

Patents and research indicators point to diverging innovation trajectories in clean energy technologies between China, the US and the rest of the world. Data from the World Intellectual Property Organization show that China accounted for approximately 50% of global clean tech patent filings in 2025, up from roughly one third in 2014, while the United States accounted for a 12-13% share.[24]

In energy-related fields, China leads in a majority of high-impact research categories linked to photovoltaics, batteries and energy storage, while the US retains relative strengths in selected upstream research domains and system-level innovation.[25] Other data on research and development intensity shows a similar divergence – China's R&D growth appears to be closely aligned with manufacturing scale-up and applied deployment, while US R&D remains more concentrated in basic research and early-stage innovation.[26]

Chinese patent strength is even more pronounced at the intersection of clean technology and digital innovation. According to the European Commission Joint Research Centre, China now holds around 79% of global patents that combine green technologies with digital capabilities, with the United States holding 6% and the European Union 2%.[27]

For investors, the implication is that clean tech should be analysed as an **integrated industrial system** rather than as a set of standalone technologies. China currently exhibits coherence and scale in manufacturing-led segments, particularly in hardware and supply chains. However, this model carries its own risks, including capital intensity, trade exposure and margin volatility. Ultimately, the competitiveness of clean electricity may now be determined less by technology cost curves and more by transmission build-out, system flexibility and planning speed across regions, as noted by the IEA.

In summary, evidence suggests a growing segmentation of technological leadership, with China advancing rapidly in applied manufacturing, process optimisation and deployment-oriented innovation, while frontier research, system integration and software-enabled optimisation remain more evenly distributed across advanced economies.

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05

It's not all about AI

According to the IEA, global data-centre electricity consumption in 2025 is estimated at around 480–500 TWh, up from roughly 460 TWh in 2024, equivalent to just under 2% of global electricity demand, with growth driven primarily by AI-related workloads.[28] Under scenarios involving rapid AI adoption, the IEA reckons that this figure could more than double to approximately 945 TWh by 2030, or just under 3% of total global electricity consumption, roughly comparable to Japan's current annual power use.

However, **growth is highly concentrated** in regions hosting clusters of hyperscale data centres. In the United States, data centres already account for around 5% of electricity demand, with some projections suggesting this could exceed 10% by 2030 as AI and cloud infrastructure scale.[29] In Europe and China, data centres currently account for roughly 2% of total electricity consumption, with demand from the sector expected to more than double by 2030.[30]

Structural electrification also looks likely to give a much bigger boost to electricity demand than AI. Even under high-growth AI scenarios, the IEA estimates that data centres, including AI workloads, will account for only around 10% of global electricity demand growth by 2030, with the remaining 90% of growth driven by structural electrification across transport, heating, industry, buildings and space cooling.[31] Electric vehicles displacing internal combustion engines, heat pumps replacing fossil-fuel boilers, rising cooling demand linked to climate change, and deeper electrification of industrial processes remain the dominant drivers of electricity demand growth. Projections of necessary energy-system investment in the context of climate change targets, for example by the European Commission,[32] also make it clear that major investment will be needed, well beyond what will be required by AI alone.

Figure 7: Increasing electricity demand for AI data centres

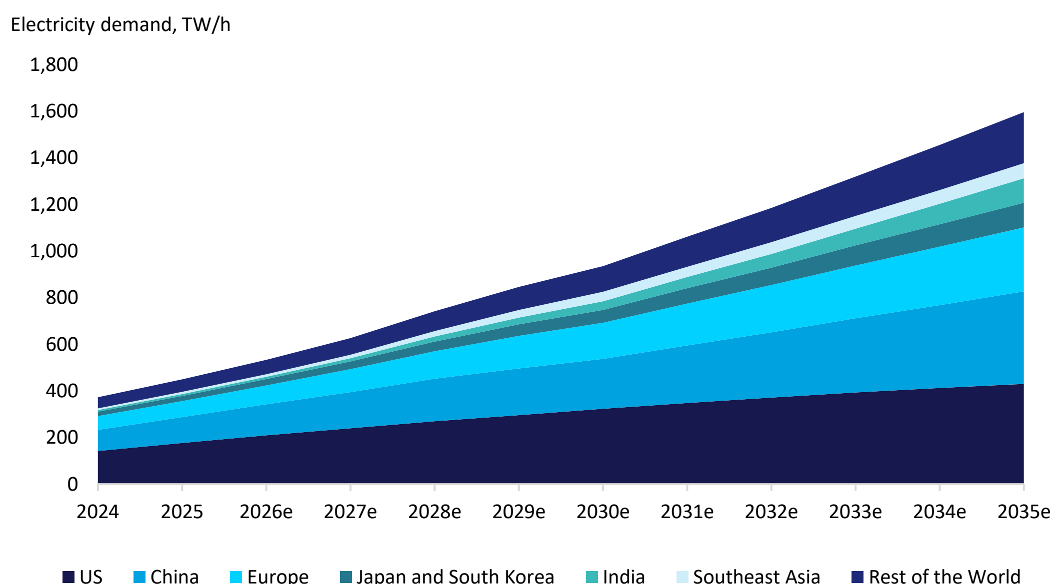

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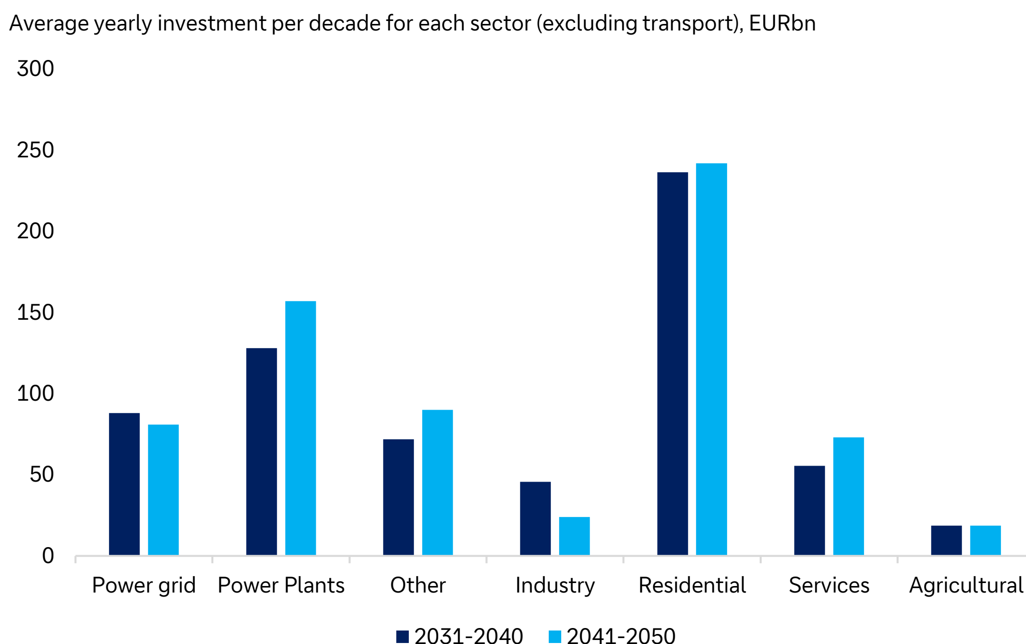
Figure 8: EU's investment needs under the central decarbonization scenario



Source: EU Climate Law impact assessment, Deutsche Bank AG. Data as of April 2026.

Average **infrastructure age** is another driver of investment. Across Europe, a large share of transmission and distribution networks are 40-55 years old, increasingly ill-suited to handle higher loads, bidirectional power flows and variable renewable generation.[33]

In the United States, much of the electricity grid was built 50-75 years ago, with nearly 70% of power transformers over 25 years old, increasing the risk of congestion and cascading failures even without additional demand from AI or electric vehicles.[34]

Required **investment levels** will be large across most economies. Deloitte estimates that the US power sector will require up to USD1.4tn of capital investment between 2025 and 2030, equivalent to more than USD230bn per year, with similarly elevated spending levels likely to persist through subsequent decades.[35] While data-centre expansion will act as an additional accelerator, the underlying investment need is driven primarily by grid modernisation, renewable integration, storage deployment, resilience measures and broad-based electrification of transport, buildings and industry.

In China, electrification-related investment is larger still in absolute terms. In 2025, China remained the largest global clean-energy investor, building on more than USD625bn in clean energy investments in 2024, accounting for nearly one third of global clean-energy investment.[36] Alongside generation, network investment is rising rapidly, with spending on transmission and distribution infrastructure reaching around USD88bn in 2025 as grids are reinforced to accommodate renewables, rising cooling demand and increasingly electrified industry. At the same time, China continued to scale energy storage at unprecedented speed. In 2025 alone, China commissioned around 66 GW / 190 GWh of new battery storage capacity, accounting for roughly 60% of global additions[37] – well above the combined deployments of the United States and

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Europe – underscoring a strategic focus on system flexibility rather than generation alone.

Overall, AI is likely to play a smaller role than the structural electrification of the economy. However, its development and deployment may in reality play two roles in the electrification and infrastructure story: as a **concentrated and locally disruptive load** that can strain grids where deployment outpaces infrastructure investment, but also as a **narrative catalyst** that has refocused attention on electricity as a binding constraint for economic and digital growth.

This distinction could matter for capital allocation. Assets and companies involved in meeting higher AI-related electricity demand may benefit in the near term, but the more durable opportunity lies in enabling the broader electrification of economies: grid reinforcement, transformers, high-voltage cables, substations, storage, EV infrastructure, heat pumps and building electrification solutions.

In short, AI represents a cyclical overlay on a secular electrification trend, not the secular trend itself, and investment strategies that conflate the two-risk misallocating capital.

06

Clean technologies, where are we?

Clean technologies have moved decisively from the periphery of the energy system to its core. This has not been due to any single breakthrough, but the simultaneous maturation of multiple technologies across generation, storage, networks and end-use electrification. The results of this (falling costs, manufacturing scale and policy alignment) have made clean energy a system-level economic and industrial strategy. China's latest Five-Year Plan (2026-2030) reflects this shift most clearly, embedding clean technologies within a broader framework of energy security, industrial competitiveness and infrastructure expansion.

Renewable power generation costs: Over the past decade, the average cost of solar photovoltaic (PV) electricity has fallen by around 90%, reaching roughly USD0.04/kWh, while onshore wind costs have declined by nearly two-thirds to approximately USD0.033/kWh. These cost reductions reflect both technological learning and industrial scale. Improvements such as high-efficiency N-type silicon cells, bifacial panels and larger, more sophisticated wind turbines have steadily raised output per unit of installed capacity. At the same time, manufacturing scale – particularly in China – has driven down component costs across the supply chain.

The result is that clean power is increasingly **price-competitive**. The most recent global assessment by IRENA shows that more than 90% of newly commissioned renewable projects deliver electricity at a lower cost than the cheapest new fossil-fuel alternatives on a levelised cost basis (i.e. combining building and operational costs, over the lifetime of the asset).[38]

Despite this, there are doubts about financial viability of some renewables projects. Offshore wind, in particular, has been affected by rising interest rates, supply-chain bottlenecks and construction inflation, leading to cancelled tenders and project delays in parts of Europe and North America. However, these headwinds appear cyclical rather than structural. Continued innovation – larger turbines, floating foundations and standardised designs – may restore momentum as financing conditions normalise.

Energy storage costs: As variable renewables scale, energy storage has moved from a supporting role to a central system enabler. Battery technology has advanced rapidly, driven by a decade of investment linked primarily to electric vehicles. By 2025, the global average lithium-ion battery pack price had declined to around USD 108/kWh,

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down from roughly USD 115/kWh in 2024,[39] with EV battery packs averaging about USD 99/kWh, remaining below the USD 100/kWh threshold.[40] Chinese manufacturers maintained a clear cost advantage, with average battery pack prices of around USD 84/kWh, materially lower than those observed in Europe and North America.[41]

These declines have fundamentally altered the economics of stationary energy storage. By 2026, the global benchmark levelised cost of a four-hour grid battery project had fallen to approximately USD78/MWh, well below the cost of new gas peaker plants (i.e. ones that operate at times of peak electricity demand), which typically exceed USD100/MWh. Solar-plus-storage hybrid projects now deliver electricity at around USD57/MWh, undercutting both coal and gas in most markets. BloombergNEF forecasts LCOE reductions of around 25% for battery storage by 2035. Deployment has accelerated accordingly with, for example, 87GW of new solar-plus-storage capacity in 2025.[42] Batteries now play multiple roles: smoothing daily solar cycles, meeting peak demand, providing frequency regulation and reducing reliance on fossil-fuel backup.

Beyond such short-duration storage, **long-duration energy storage (LDES)** is emerging to address multi-day variability. In 2025, global LDES deployment reached 2.0GW/9.6 GWh, largely concentrated in China, bringing cumulative capacity to 5.1 GW. New deployment is expected to nearly quadruple in 2026. While still small relative to total power demand, LDES technologies are increasingly viewed as critical to enabling very high renewables penetration over the long term.

As LDES emerges to address multi-day variability, battery R&D is also focusing on **materials innovation** to reduce reliance on supply-constrained inputs. One approach is to substitute scarce, geopolitically concentrated metals with abundant alternatives: **lithium iron phosphate (LFP)** batteries now constitute almost half of new EV battery capacity, eliminating cobalt and nickel. Similarly, prototype **sodium-ion cells** – using sodium, which is over a thousand times more abundant than lithium – are being piloted for stationary storage despite lower energy density. Meanwhile, advanced recycling can recover ~90% of critical metals from spent cells, gradually expanding secondary supply and easing future constraints.

Grid flexibility: So-called grid-enhancing technologies – such as dynamic line rating, advanced power-flow control devices and topology optimisation software – can increase the capacity of existing lines by 20-30% at relatively low cost.[43] Globally, dynamic line rating alone could unlock over 160 GW of additional transfer capacity by adjusting operating limits in real time based on weather and load conditions.[44]

Regulatory innovation on grids may proves equally important. **Conditional or non-firm grid connections** could unlock an estimated 750–900GW of stalled renewable projects by allowing faster interconnection with occasional curtailment during congestion[xiiv]. These approaches shift grid planning away from worst-case assumptions toward probabilistic, system-optimised operation.

China again illustrates the scale of ambition required. Its state grid operator plans to invest RMB 4 trillion (over USD550bn) during 2026-2030, a 40% increase on the previous five years. This includes the construction of 15 new ultra-high-voltage transmission lines by 2030.

Transport electrification: Global electric car sales exceeded 17 million in 2024, up 25% year-on-year and accounting for more than one in five new cars sold; in 2025, sales are expected to rise to around 18–19 million units - roughly one in four new cars globally—driven by China, where EV sales are projected to exceed 12 million units, compared with around 1.7 million in the US.[45] Battery cost declines have narrowed or eliminated price gaps while expanding model choice and driving ranges. Attention is now shifting to heavy-duty vehicles, logistics fleets and deeper grid integration through smart charging and vehicle-to-grid services.

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Electrification of heating and industrial processes. Many areas here have long been considered difficult to decarbonise, but technology is making it easier. The global heat-pump market reached around USD50–55bn in 2024 and remained at a similar scale in 2025,[46] following sustained average annual growth of more than 5% since the mid-2010s. China continues to lead in installation volumes, while the United States remains the largest market by value. Modern heat pumps deliver three to five times more heat per unit of electricity than gas boilers deliver per unit of fuel, making them economically attractive over their lifetime. But economic and institutional barriers remain, with energy market structures often meaning that electricity prices are structurally higher than gas prices, requiring policy reform.

Industrial electrification presents additional challenges. Existing technologies can address most low- and medium-temperature heat demand, but high-temperature processes require emerging solutions, including advanced electric boilers, hydrogen or nuclear-derived heat. Nevertheless, innovation is accelerating, positioning industrial heat as a major long-term growth area for clean technologies.

Hydrogen: Progress has been slower than early expectations. Global hydrogen demand of around 100mn tonnes in 2024 was also almost entirely met by fossil fuel-based supply. Production of green hydrogen (produced by electrolysis using renewable energy) and blue hydrogen (using natural gas, but with carbon capture) increased by around 10% in 2024, but deployment remains modest. While electrolyser-based hydrogen capacity expanded rapidly in 2024, growth started from a very low base, and overall deployment remains modest despite rising investment going into 2025.[47]

Green hydrogen remains expensive, meaning that government encouragement (e.g. the EU requirement that 42% of industrial hydrogen consumption be renewable by 2030) may initially not gain traction. Over time, falling electrolyser costs and policy support may unlock broader adoption. China accounting for 65% of installed electrolyser capacity and nearly 60% of manufacturing output: its Chinese alkaline electrolysers cost roughly USD 600–1,200 per kW, **around** one-third of prices elsewhere.

For now, hydrogen may be best viewed as a targeted complement to direct electrification, best suited to long-duration storage, high-temperature industry and long-haul transport.

Nuclear power: This continues to offer the prospect of reliable, zero-carbon electricity and supplies roughly 18% of US electricity and 25% of Europe's.[48] However, expansion has slowed in western markets due to high costs and long construction timelines. China again presents a contrast: 61 reactors were operating and 39 were under construction as of early 2026. Standardisation and scale have dramatically reduced construction costs and timelines, with some projects completed in under seven years. By 2030, China is expected to overtake the United States as the world's largest nuclear power producer.

Small modular reactors (SMRs) may represent the next phase. SMRs enable factory-based construction and new applications, including industrial cogeneration. Fusion research also appears to be advancing although commercial fusion remains distant.

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07

Conclusion

The advantages of electrification – bridging both economic resilience and sustainability – mean that it is now a focus for energy and economic transition. In this new age of electricity, high levels of investment have already profoundly changed its supply and distribution mix: the evolution of clean power from a subsidised niche to a mainstream investment essential is only one example of this.

Recent developments around the Strait of Hormuz have underlined the importance of electrification as a **geopolitical strategy**. The **expanding role of the state** in energy systems – to coordinate systems with long investment cycles, network effects and strategic dependencies – predates such concerns. Studying the reasons behind China's position of strength illustrates the importance of different financing and policy frameworks, inter alia.

Structural electrification likely to give a much bigger boost to electricity demand than does AI and will require major investment. Clean technologies now lie at the core of the energy system but are still dependent on old calculations: power generation and energy storage costs, the availability of long duration storage, grid flexibility and so on. Not all new technologies will necessarily deliver.

Electrification is a process that has much further to run and brings in many other issues, not just decarbonisation and energy security. In our next publication, *Investing in electrification*, we discuss how to categorize these and identify specific themes, strategies and risks.

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Appendix

Glossary

Battery Energy Storage Systems (BESS) store electricity in rechargeable batteries and release it when needed. They convert electrical energy into chemical energy during charging and back into electricity during discharge, helping balance supply and demand, stabilize power grids, and integrate intermittent renewable energy such as solar and wind.

Blue hydrogen is hydrogen produced from natural gas with the associated carbon dioxide captured and stored rather than released into the atmosphere.

Carbon capture is the process of capturing carbon dioxide emissions from industrial activity or fuel use so that they can be stored or reused rather than released into the atmosphere.

Chokepoints are narrow transport routes or strategic passages through which large volumes of energy supplies move, making them vulnerable to disruption.

Critical minerals are minerals such as lithium, cobalt, nickel and rare earths that are essential for clean-energy technologies and other strategic industries.

Critical raw materials (CRMs) are raw materials considered economically important and at risk of supply disruption, making them strategically significant for industry and energy systems.

Data centres are facilities that house computing and data-storage equipment and consume large amounts of electricity to power servers and cooling systems.

Decarbonisation is the process of reducing carbon dioxide emissions across energy use, industry and the broader economy.

Energy Information Administration (EIA) is the statistical and analytical arm of the U.S. Department of Energy, responsible for collecting, analyzing and publishing data on energy production, consumption and markets.

Global battery manufacturing refers to the worldwide production of batteries, especially lithium-ion batteries used in electric vehicles, storage projects and other clean-energy applications.

Green hydrogen is hydrogen produced by electrolysis using electricity from renewable sources, resulting in very low associated carbon emissions.

Hydrogen is a chemical element that can be used as an energy carrier, particularly in industry, long-duration storage and transport.

The **International Energy Agency (IEA)** is an intergovernmental organisation that analyses energy markets, policies and technologies.

Integrated industrial system refers to a closely connected production ecosystem in which manufacturing, supply chains, technology development and deployment reinforce each other.

International Renewable Energy Agency (IRENA) an intergovernmental body focused on renewable-energy deployment and policy.

Lithium-ion battery pack is a battery system made up of multiple lithium-ion cells and associated control components, commonly used in electric vehicles and energy storage.

Long-duration energy storage (LDES) is energy storage designed to discharge power over longer periods, often many hours or days, to manage prolonged variability in electricity supply and demand.

Liquefied Natural Gas (LNG) is natural gas that has been cooled to a liquid state for ease of storage and transport, particularly over long distances by ship.

Solar-plus-storage refers to energy projects that combine solar generation with battery or other storage so that electricity can be delivered more flexibly over time.

State intervention refers to direct government action in the economy through funding, regulation, ownership or strategic policy measures.

Topology optimisation software is software that improves the configuration and routing of electricity flows across a grid to make better use of existing infrastructure.

Transmission infrastructure refers to the high-voltage networks and associated equipment used to transport electricity over long distances.

Ultra-high-voltage transmission lines are very high-capacity power lines designed to move large volumes of electricity efficiently across long distances.

Vehicle-to-grid services are systems that allow electric vehicles to send electricity back to the grid or provide balancing services when connected.

World Trade Organization (WTO) is the international organization that sets and enforces the rules governing global trade between nations..

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