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ENERGY

Why the grid could make or break the electro-tech revolution

Electricity is becoming a stronger economic growth engine, powering AI data centres, EVs, heat pumps and industrial decarbonisation. But grids aren't keeping up. Connection delays of four to nine years highlight the importance of heavy electricity users in making their demand smarter and more flexible



The 136.8km Xiangjian-Ludao 500-kV power transmission line in China's Anhui Province

Today's electro-tech revolution has a grid problem

The global economy is shifting from *molecules* to *electrons*. That is, relying less on burning fuels and more on electricity to power growth – largely thanks to technological advancement. This shift is increasingly known as the '[electro-tech revolution](#)'.

You can see it everywhere: AI data centres are driving a surge in electricity demand; vehicles are increasingly electric rather than gasoline-powered; buildings are switching to electric heat pumps; and industries are beginning to replace fuel combustion with electric processes.

The scale of this shift is significant. The International Energy Agency expects new electricity uses to add more than [10,000TWh](#) of demand between 2024 and 2035, around 50% more

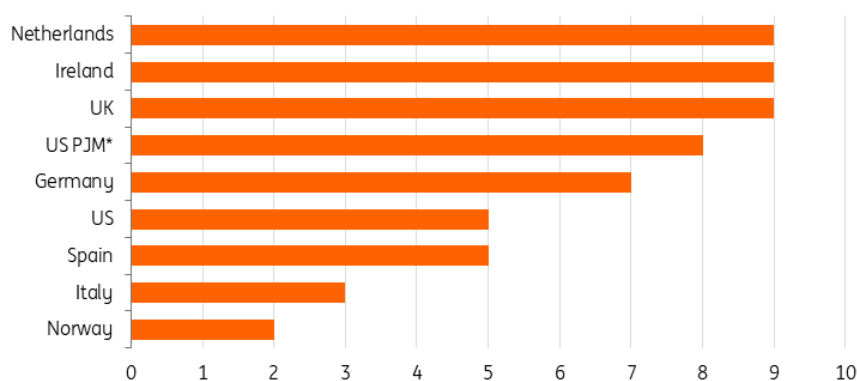
than the increase seen between 2013 and 2024.

But the grid is becoming a real bottleneck. In many parts of the world, there is not enough capacity to move electricity from where it is generated to where it is needed, especially during peak demand hours or when solar and wind output is high.

This is known as **grid congestion**. Its most direct consequence is that both power producers and large electricity consumers **need to queue up to be connected to the grid**. Lead times for new grid connection differ strongly by location, but in several developed markets they can range from four to nine years. Moreover, power producers with excess generation might be curtailed or receive lower (even zero) prices for their production.

Grid connection queues can easily stretch 5+ years in Western economies

Average years needed to get any new grid connection in selected jurisdictions

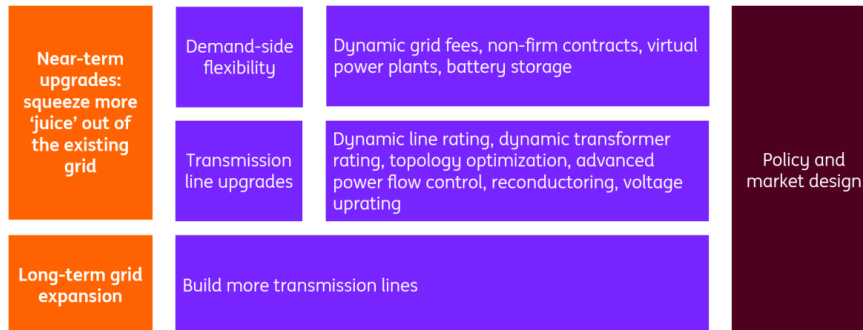


Source: ING Research, Rocky Mountain Institute, Berkeley Lab, Ember Energy.

*The US PJM power market is the largest wholesale power market in the US operated by PJM Interconnection. It includes major demand centres like Pennsylvania, New Jersey, Maryland, Illinois, Ohio, and Washington DC.

That has real economic consequences. Power projects can face delays, undermining financing and development timelines. Large users such as data centres, manufacturers, logistics companies, and real estate developers may have to postpone expansion or decarbonisation plans. This also comes at a high cost to society. [Research](#) for the Netherlands, for example, suggests that the economic value that could be created with an additional MWh of electricity is around 35 times higher than the cost of supplying that MWh. When grid congestion prevents that electricity from being delivered, that value remains unrealised.

Short and long-term solutions that can support grid enhancement



Source: ING Research

How grid capacity can be enhanced: quick wins and long-term planning

The good news is that this is not a problem without solutions.

In the **near term**, the priority should be to get more capacity out of the existing grid, even if that requires changes to long-established market rules. Businesses in regions with grid congestion can no longer assume unlimited power access and will need to become more flexible in electricity use to ensure timely expansion.

The **long-term** solution is expanding the grid, building new transmission lines, substations, and digital infrastructure. This solution is a lot more capital intensive and takes longer to realise, but successful early planning and investment can have tremendous compounding benefit over decades.

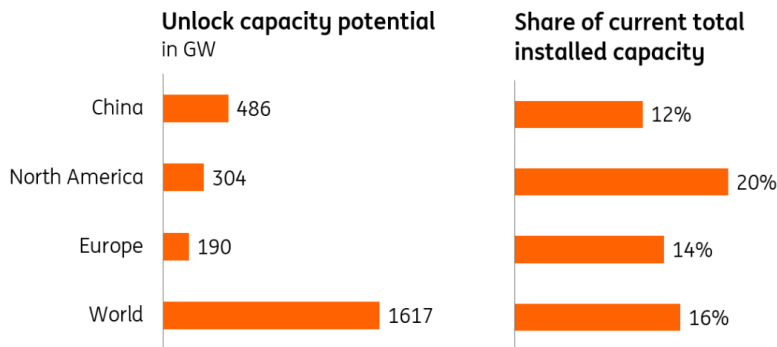
1. Near-term upgrades: squeezing more 'juice' out of the existing grid

When thinking about raising grid capacity, one might envision building new infrastructure. That works in the long term, but the quickest gains come from better usage of the existing grid.

To achieve that, two mechanisms stand out: **demand-side flexibility** and **transmission line upgrades**. These options could together unlock up to 1,600GW of additional capacity globally, equal to over 15% of today's installed power capacity. These solutions are critical for companies needing power in the near term, as they require less capital and can be rolled out more quickly.

Significant grid capacity can be unlocked through improving the existing infrastructure

Capacity potential in GW, share in %



Source: ING Research, International Energy Agency, US Energy Information Administration, Statbase, China National Energy Administration, Eurelectric

Demand-side flexibility

Grid constraints often arise because transmission capacity is insufficient during peak hours, despite spare capacity at other times. As utilities increasingly offer faster connections to flexible users, electricity-intensive companies should build flexibility into their energy planning.

Below are some effective ways to enhance demand-side flexibility:

- **Dynamic grid fees** use price signals to ease congestion. Similar to spot power markets, where prices reflect real-time conditions, grid tariffs can be made higher when the network is constrained and lower when capacity is available. This allows heavy electricity users to reduce grid costs by shifting consumption to off-peak hours. It is suitable for automated operations that can reschedule power use without affecting daily output (e.g., cement plants, pulp mills).
- **Non-firm contracts** provide a more structured version of the same principle. Instead of guaranteeing grid access at all times, these contracts reduce peak-hour demand while allowing more electricity use during non-peak periods. For electricity users that can shift demand, this can mean faster grid connection, lower costs, or both.
- **Virtual power plants (VPPs)** aggregate distributed resources, like EVs and flexible industrial loads (e.g., air compressors, hydrogen electrolysis), so they can shift demand and discharge stored power when needed. The collective opportunity is significant: US VPP capacity reached [38GW](#) last year, equal to 6% of average peak demand in late June this year. Nevertheless, today's active VPP usage is only a fraction of its capacity. The opportunity now lies in scaling and design improvement. Doubling capacity could have a significant impact, making early engagement important for corporates. Google's recent [partnership](#) with VPP operator Voltus highlights growing interest in the space. Looking

ahead, AI can help optimise VPP design by enabling more advanced demand-shifting solutions.

- **Utility-scale batteries** add flexibility by storing excess power and discharging during peak demand. Increasingly, they are valued not only for supporting generation but also for managing grid congestion. Dynamic grid fee pricing and non-firm contracts both encourage investment in battery storage. Batteries also improve grid stability through ancillary services (frequency stabilisation), helping operators balance the system more efficiently while improving battery asset revenue streams.

Vehicle-to-grid remains promising, but not yet scalable

Vehicle-to-grid (V2G) is often highlighted as a building block of future VPPs. In theory, EVs could act as a sizeable distributed battery fleet, but in practice, adoption remains limited.

Much of the challenge lies with carmakers. To protect battery warranties, manufacturers often cap V2G usage to a few hundred hours over a vehicle's lifetime, limiting V2G's economics. Grid operators are also cautious. EVs are mobile and not always plugged in, making their availability uncertain. Technical design adds further complexity, including whether to place the [inverter](#) inside the EV or outside by the chargers.

These constraints explain the slow progress. Without stronger policy support, other measures like demand response and stationary storage would play a more immediate role.

Transmission line upgrades

- **Dynamic line rating (DLR)** is a good example of how **software** improvement can free up existing grid capacity. Think of the grid as a road, where a fixed traffic limit always assumes the worst road conditions. DLR would raise that limit when grid conditions are good, allowing more electricity to flow safely. In the US, Ameren is [working](#) with Heimdall Power to test this technology on congested lines.
- **Hardware** upgrades can also help. **Advanced conductors** use new materials and designs to carry more electricity through existing infrastructure, sometimes doubling capacity. CTC Global has announced a [partnership with Google](#) to deploy next-generation conductors.

2. Long-term expansion: building more transmission lines

While near-term grid enhancement strategies should focus on using the existing grid more effectively, this does not negate the need for grid expansion. The power system of the future will require denser, higher-voltage, and more digital networks. However, grid expansion is highly capital intensive and can take up to a decade. For grid expansion to be cost-effective, new capacity needs to be built where power demand is growing. This helps keep grid utilisation high and lowers costs per MWh.

That is why early investment and careful planning matter. Capital deployed today based on systemic research of future demand can have large compounding benefits in a decade's time.

China leads, while the US and Europe try to catch up

Governments' ability to better utilise and expand grid infrastructure will increasingly shape business growth and national competitiveness.

China has outpaced the US and Europe, as centralised planning has enabled large-scale deployment of ultra-high-voltage lines. China now has the world's largest power grid: it has over 12 million km of transmission lines, thousands of which are of ultra-high-voltage. It also has a younger asset base, with 40% of its transmission lines built within 10 years (vs 20% in the US and 30% in the EU).

But China's grid still faces pressure from rapid renewable development and electrification. So the country continues to enhance its grid, meanwhile streamlining interconnection approvals. This keeps grid lead times shorter than in the West, giving China an edge in advancing strategic ambitions like AI.

The **US** is under greater grid strain from ailing infrastructure, underinvestment, and surging data centre demand. This is compounded by slow interconnection processes. While reforms are underway, their full impact is not yet material. US policy (rightfully) focuses on maximising existing capacity; the Department of Energy committed \$1.9bn in March to accelerate upgrades, and the [Federal Energy Regulatory Commission \(FERC\)](#) in June mandated reforms from grid operators. It marks a meaningful federal move to accelerate grid access for data centres, while ensuring they contribute to grid flexibility in return.

Europe also faces substantial grid congestion. It is addressing it through both near and long-term solutions. For the near term, demand flexibility mechanisms dominate. By late 2025, 15 member states offered non-firm agreements. Many are also prioritising interconnection for projects that improve grid flexibility. For the long term, the EU's Grid Package targets €472 billion in investment to expand transmission capacity by 50% by 2040. This level is only about a third of what is needed, but does represent a significant step. The real challenge is execution, which highly relies on reducing cross-border regulatory hurdles.

In short, grid availability has become a key consideration for large electricity consumers. Many cannot afford to wait years before pursuing their growth plans. China's leading position gives it an advantage in attracting investment. Western economies are playing catch-up in aligning grid capacity with business leaders' investment horizons – and we do think their efforts would pay off.

For businesses, flexibility brings faster power access

Corporates in the US and Europe with plans to expand their footprint need to proactively be more flexible in power demand. The upside is getting connected to the grid faster, securing better rates, and improving the business case for growth. The Netherlands' transmission system operator [TenneT](#) last year fast-tracked grid connection for 57 flexible users, including battery parks and hydrogen electrolyzers. In the US, [Portland General Electric](#) used Gridcare's software to find unused grid capacity that would be made available to flexible data centres.

- Large, energy-intensive companies with high capex plans would benefit from deploying batteries or on-site generation to increase flexibility.
- Smaller companies, or firms with multiple sites, can work with flexibility-as-a-service providers or VPP operators.
- Data centres and other less flexible users will need a mix of batteries and demand optimisation. Our [analysis](#) shows that data centres can shift time-flexible workloads, such as machine learning, while batteries can provide flexibility across more workloads.

Demand-side flexibility can also deliver societal benefits. In the Netherlands, large electricity users pay around €100/MWh, while grid constraints can cost society €3,500/MWh in lost economic value. The impact is even greater when housing delays, slower electrification, and missed decarbonisation benefits are included. This means even relatively expensive measures, such as adapting industrial operations, may be worthwhile. It also strengthens the case for policy support to scale grid flexibility technologies and practices.

In summary, the electro-tech revolution will only scale if the grid can keep up. That requires more investment in new infrastructure, but also smarter use of what already exists. For policymakers, grid policy is now industrial policy. For grid operators, flexibility can buy valuable time. And for businesses, managing electricity demand is not just an operational issue. It is becoming central to competitiveness, decarbonisation, and growth.

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