

Transmission Bottlenecks and the Energy Shift

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The global energy transition hinges on modernizing and investing in transmission and distribution (T&D) infrastructure, yet supply chain bottlenecks and underinvestment threaten to derail progress.

Electrification pushes power into every part of daily life. Heat, transport, data centres and industry all add load. At the same time variable generation reshapes flows. Networks need capacity, flexibility and digital control. Most spend this decade will be in distribution networks near customers. The rest is high voltage backbones that connect new generation and increase cross border trade.

The U.S. alone needs to double or triple its transmission capacity to meet net-zero goals. However, permitting delays, regulatory fragmentation, and local opposition have slowed progress. Projects often take a decade or more to complete, far outpacing the deployment timelines of wind and solar farms. This mismatch means that clean energy projects are increasingly stranded - built but unable to connect to the grid.

Globally, while renewable generation is scaling up, the supporting infrastructure is not keeping pace. In Europe, for instance, grid congestion is already forcing curtailments of renewable output, undermining both economic returns and decarbonization targets.

Where the grid is stuck

BOTTLENECK	WHAT IT MEANS	WHY IT HAPPENS	SIGNALS TO WATCH	INVESTMENT ANGLE
Connection queues	Projects wait years for a grid slot	Studies take too long and many projects hold places they will never use	Queue reform, milestone gates, withdrawal of inactive projects	Developers with shovel-ready assets, grid service firms, flexible connections
Permitting and planning	Long reviews before construction	Complex rules and local concerns	Statutory time limits, standard designs, community benefit funds	Early-stage grid developers, design for manufacture and assembly, modular sites
Transformers	Long lead times and tight capacity	Limits in core steel, test bays, skilled labour	New factories, qualified lines, order backlogs and pricing discipline	Large power and MV-LV transformer makers, tap changers, bushings, core steel
Cables	Multi-year slots for HVDC and subsea	Few specialised plants and high copper or aluminium input	Plant expansions, firm take-or-pay contracts, material hedging	Cable makers, accessories, installation vessels and services
Switchgear and protection	Need for compact MV in cities and safe SF6-free tech	Urban build limits and environmental rules	Adoption of alternative gases and digital relays	MV switchgear makers, retrofit kits, condition monitoring

BOTTLENECK	WHAT IT MEANS	WHY IT HAPPENS	SIGNALS TO WATCH	INVESTMENT ANGLE
Labour and execution	EPC capacity and skilled crews are scarce	Ageing workforce and peak demand cycles	Training partnerships, offsite assembly, higher utilisation	Grid EPCs, modular substations, mobile transformers
Capital and incentives	Utilities delay spend without visibility	Regulatory lag and return uncertainty	Anticipatory investment allowances, non-wires alternatives	DSOs and TSOs with clear capex plans, flexibility market platforms
Grid visibility and control	Low data and slow control reduce usable capacity	Legacy systems and poor integration	ADMS, DERMS, flexible connection offers	Software platforms, sensors, analytics, VPPs

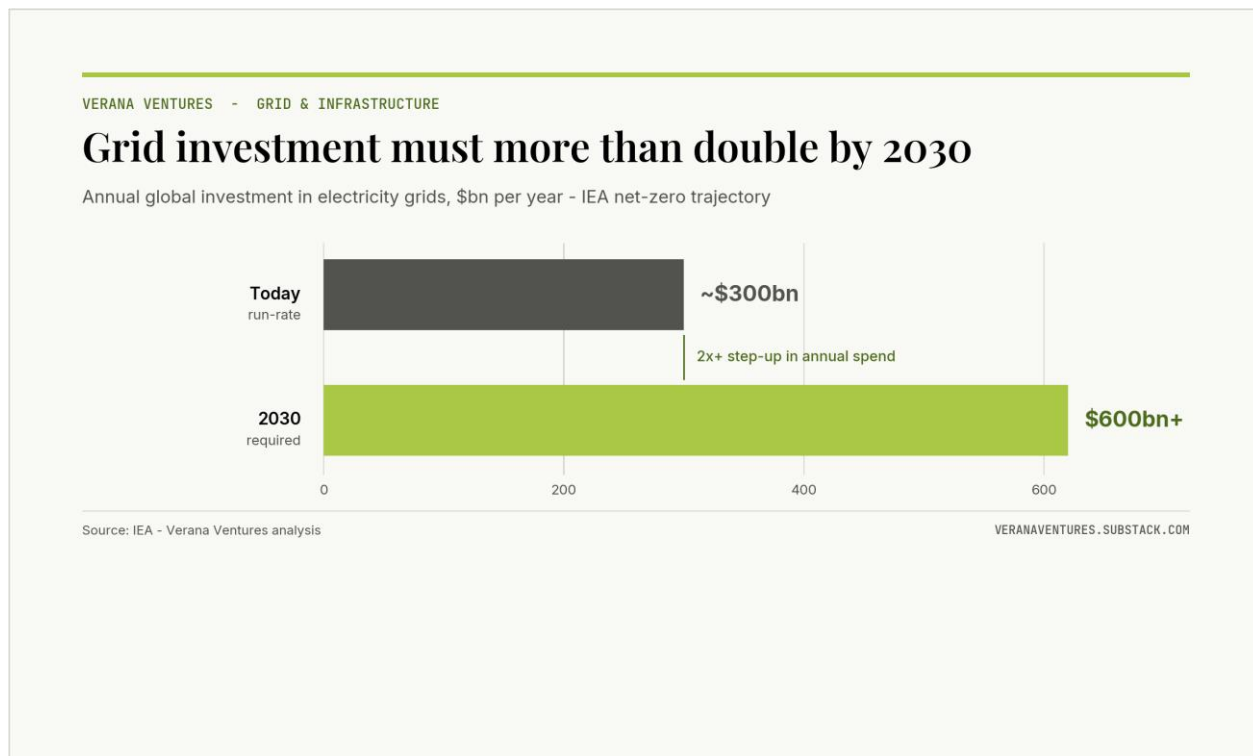
Eight bottlenecks across the T&D build-out - what they mean, why they persist, and the investment angle on each.

T&D Supply Chain Under Strain

The T&D supply chain is facing its own set of challenges. The industry is grappling with shortages of critical components like transformers, cables, and switchgear. These shortages are exacerbated by limited manufacturing capacity, long lead times, and geopolitical uncertainties that disrupt global trade flows.

Moreover, the workforce needed to build and maintain grid infrastructure is aging, with a shortage of skilled labor threatening to delay projects further. The complexity of integrating new technologies, such as smart grids, battery storage, and distributed energy resources adds another layer of difficulty.

IEA estimates that annual global investment in grids must more than double to over \$600 billion by 2030 to stay on track for net-zero. This includes not only building new lines but also upgrading existing infrastructure and deploying digital technologies to enhance grid flexibility and resilience.



Where to Invest?

THEME	WHAT TO BUY	WHY IT WINS	WHAT TO TEST IN DILIGENCE
Platform OEMs	Transformers, HVDC cables, MV switchgear, protection	Structural volume growth and price power while supply is tight	Backlog quality and margins, raw material hedging, factory debottlenecking, service density
Tier-two suppliers	Core steel, windings, resins, tap changers, bushings, cable accessories	Easier to scale and essential to performance	Customer qualification moats, long contracts, capacity ramps
Distribution focus	Secondary substations, pole-top transformers, compact MV gear, smart meters	Most spend is near customers and cycles are faster	Product approvals with DSOs, urban install track record
Digital grid	ADMS, DERMS, topology and state estimation, flexibility platforms	Software margins and rapid procurement	Proven deployments, integration stack, attach to hardware fleets
Build and repair	Modular substations, mobile transformers, testing and commissioning, outage recovery	Short supply chains and time-critical revenue	Utilisation rates, framework agreements, response times

Five themes across the grid supply chain - what to buy, why it wins, and what to test in diligence.

Private capital is increasingly stepping in, but policy support remains essential. Streamlining permitting processes, standardizing regulations across jurisdictions, and incentivizing domestic manufacturing of key components are critical steps. Public-private partnerships can also play a pivotal role in de-risking large-scale grid projects.

The energy transition is not just about generating clean power, it's about delivering it. Without robust T&D infrastructure, the promise of renewables will remain unfulfilled. Addressing supply chain bottlenecks and scaling investment in grid modernization must become top priorities for policymakers, utilities, and investors alike.

SOURCES

No Transition without Transmission - Global Energy Perspective: Transition Bottlenecks and Unlocks - Tackling Supply Challenges in T&D