Special Report

Grid Modernization: Infrastructure, Investment, and Innovation

aranca

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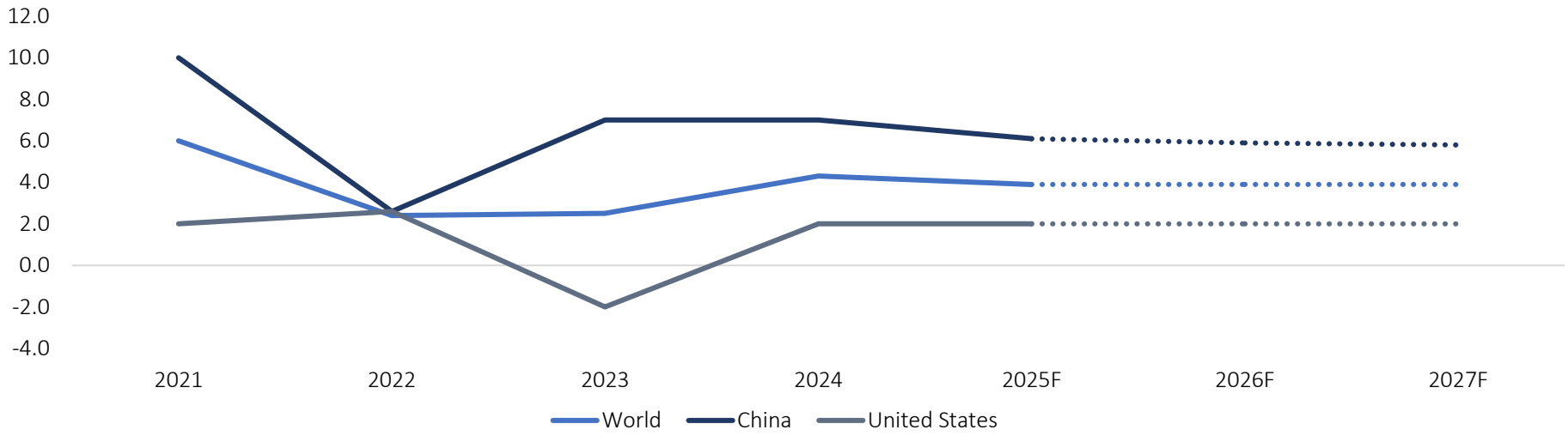
Contents

An Overview of the Electricity Industry

Global Power Demand Surges as Electrification Expands

Global Electricity Demand (YoY %)



- Global electricity consumption grew 4.44% in 2024, up from 2.5% in 2023, driven by accelerating electrification across transport, industry, and households.
- The IEA refers to this shift as the “New Age of Electricity,” underpinned by rapid adoption of low-emission technologies and digital solutions.
- From 2025 to 2027, clean energy sources are expected to meet all additional electricity demand, aligning growth with global climate targets.
- Demand growth is projected at 3.3% in 2025 and 3.7% in 2026, with a slight moderation attributed to a softer global GDP outlook.
- Key demand drivers include industrial expansion, rising air-conditioning loads, the rapid build-out of data centers, and continued electrification across sectors.
- Electricity demand is expected to grow at more than twice the pace of the total energy demand in the coming years.
- By 2026, global electricity consumption is forecast to exceed 29,000 TWh, from 27,400 TWh in 2024, reinforcing electricity’s expanding role in the energy system.

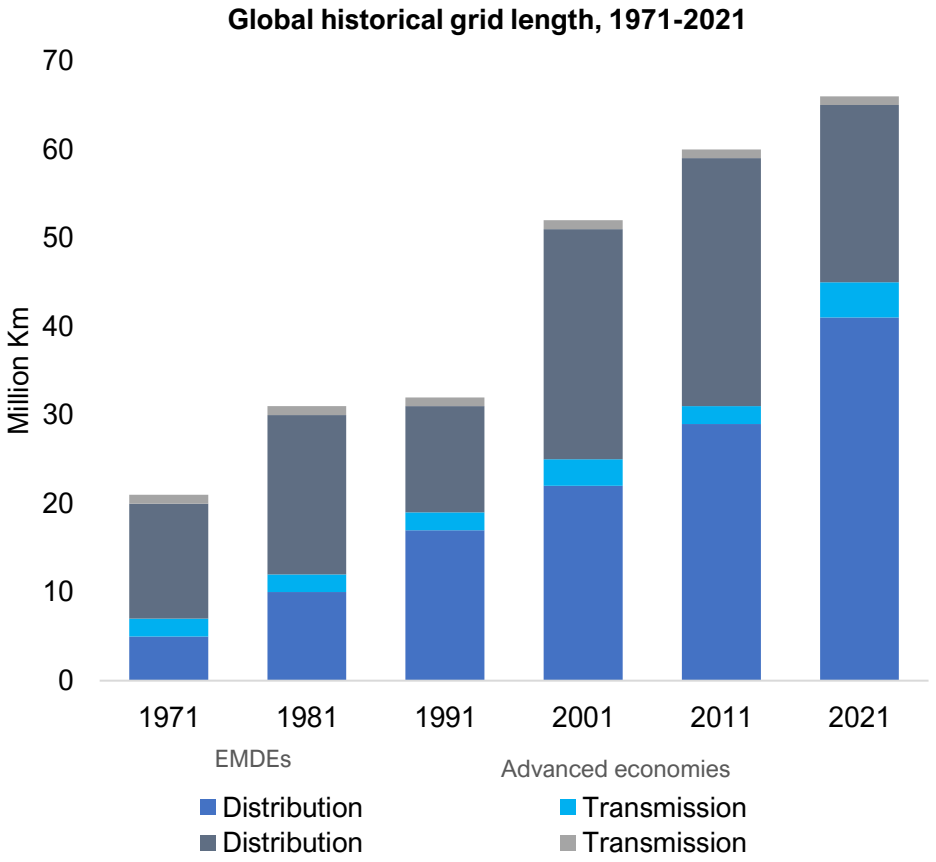
Source: *IEA*

Why Grid modernization matters for industry electrification?

The Urgent Need to Modernize Global Electricity Grids

Global Historical Grid Length (Million Km)

- Electricity grids worldwide are aging and no longer suited to a complex and rapidly changing energy system. Although they remain the backbone of power supply, they receive far less focus than generation or storage.
- The shift to decentralized and variable renewable energy is exposing bottlenecks in old infrastructure, especially in industrialized countries with distribution lines over twenty years old. Without upgrades, reliability and energy security are at risk.
- Grid length has almost doubled over the past 50 years and is expected to double again by 2050 to 215 million circuit kilometers (c-km), from 65 million km in 2021.
- Electricity transmission and distribution networks are at the heart of the energy transition. Policymakers and energy leaders increasingly emphasize a simple truth: the transition cannot happen without robust transmission, and sustainable solutions rely on resilient distribution.
- Transmission lines account for just 7% of the total grid length, while distribution networks continue to dominate global expansion. Their growth is vital for both reliability and access.
- Over the past 50 years, grids have grown by about one million kilometers per year, with most of this growth in distribution networks. By 2021, global grid length reached almost eighty million kilometers. Low voltage and medium voltage lines that serve homes, businesses and industries form the core of the distribution grid.



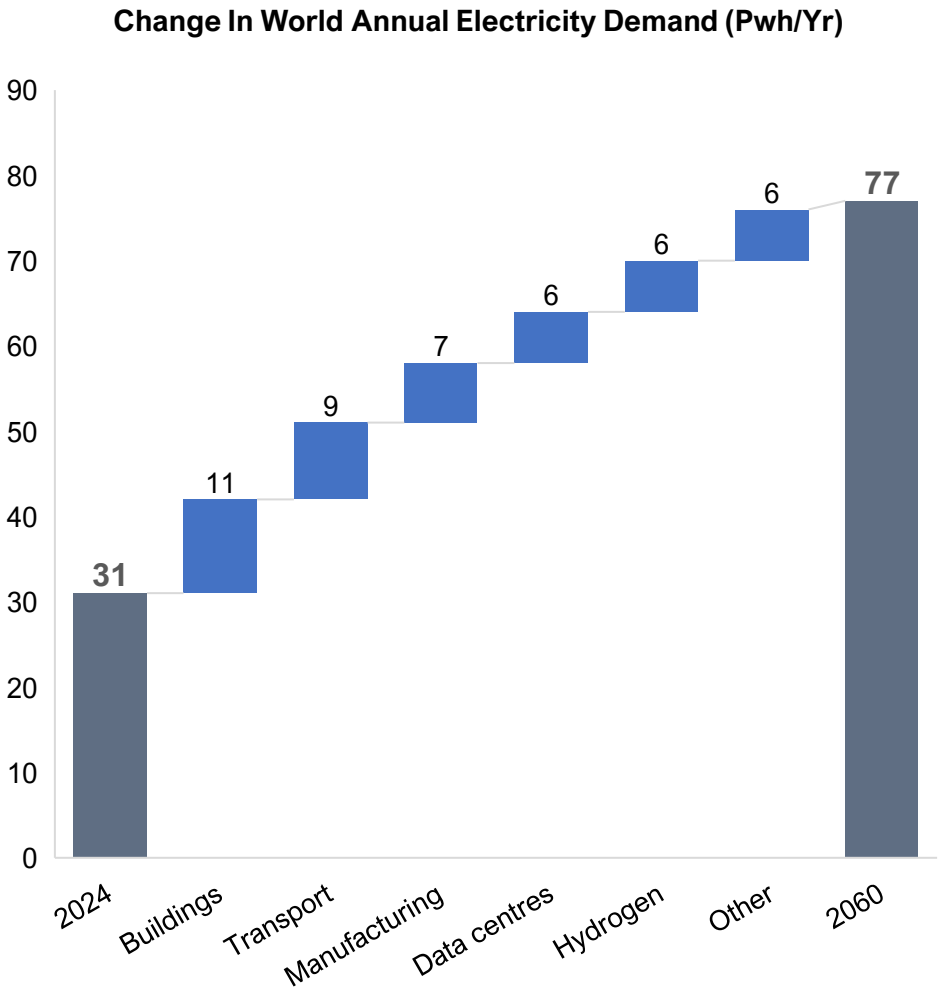
Source: *IEA, Note- EMDE- Emerging market and Developing economies*

Key Drivers of Grid Modernization

Buildings and transport account for the largest contributions to the global electricity demand through 2060

The global electricity demand is projected to more than double by 2060, rising from 31 petawatt-hour per year (PWh/yr) in 2024 to 77 PWh/yr, inclusive of the energy sector's own use and transmission and distribution (T&D) losses. Growth is broad based, but the largest structural drivers are:

- **Buildings:** Buildings: Electricity demand rises with urbanization, population growth, and higher living standards, increasing the use of appliances, lighting, and HVAC systems. Efficiency gains limit growth in high-income regions, but rapid electrification elsewhere lifts building-sector demand to ~11 PWh/yr by 2026.
- **Transport:** Electrification of mobility continues to advance rapidly. The global EV fleet is expected to expand significantly, reaching 3.3 billion vehicles by 2060, which will require ~9 PWh/yr of electricity when fully scaled.
- **Industry:** Increased use of electrification for the generation of manufacturing and process heat, especially via industrial heat pumps for low/medium temperature processes, raises the electricity's share of industrial energy use.
- **Data centers & AI**: Rapid data center buildout are a major incremental demand source, with North America the biggest growth driver, using 6 PWh/yr of electricity.
- **Hydrogen:** Grid connected electrolysers are a significant load, using 6 PWh/yr by 2060, particularly in renewables-rich regions (Europe, MENA, OECD Pacific).



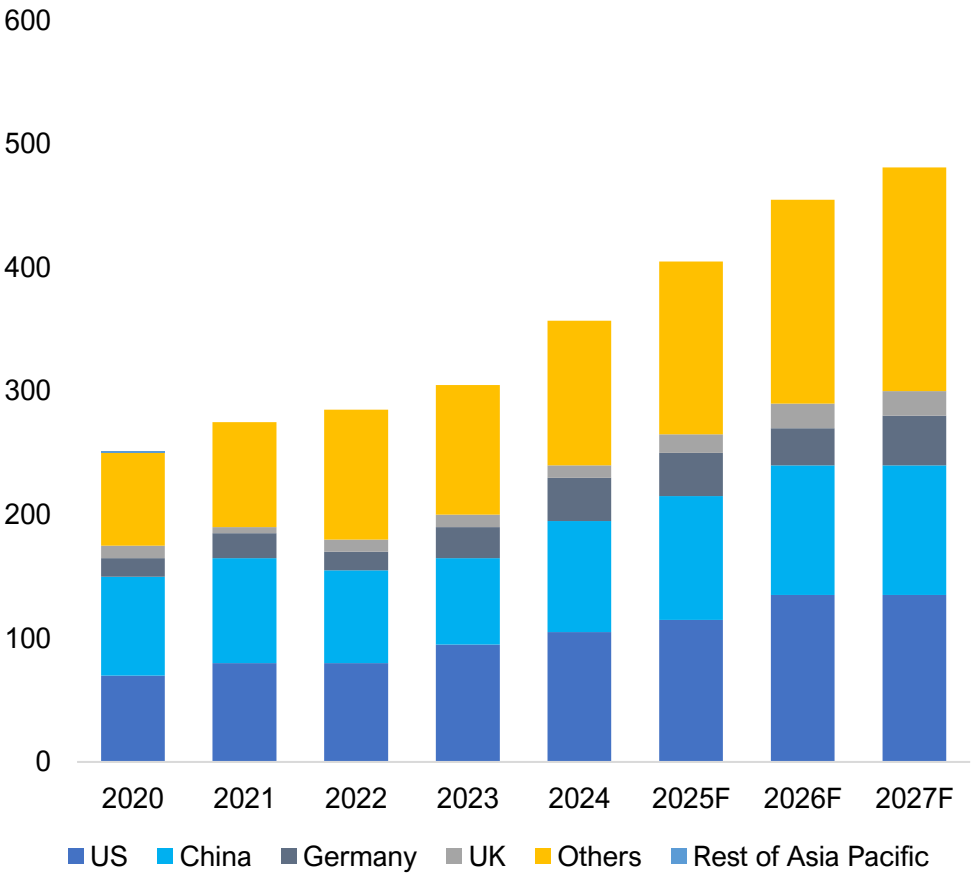
Source: *DNV Energy Transition Outlook 2025*

The New Grid Reality: Investment Breaks Historic Records

Record investment, regional momentum, and the urgent need for transmission expansion

- **Record-high spending**: Global electricity-grid investment is expected to exceed USD 470 billion in 2025, the first time it will cross that threshold, and mark a 16 % yoy increase, continuing the double-digit growth seen in 2024.
- **Major contributors**: The United States remains the largest investor, providing USD 115 billion (~25 % of the global total), while China and the EU/UK each supply ~20%.
- **Transmission vs. distribution**: Spending on transmission networks is projected to grow at ~16 % CAGR (2024-27), nearly double the ~9 % growth rate forecast for distribution.
- **Demand drivers**: The rise in investment is driven by the need to connect renewable energy projects, achieve electrification goals and meet the surging power demand from data centers and industrial loads.
- **Financing pressures**: Although debt remains the primary source of funding, some markets are approaching the borrowing limit, making new equity injections necessary to maintain financials.
- **Persistent bottlenecks**: High equipment costs and inflation mean that increased spending does not fully resolve grid-capacity constraints; queue times for connecting new generation and demand are still long.
- **Emerging technologies**: Investment in smart- and digital-grid solutions, including dynamic line ratings, advanced power-flow controls and AI-driven software, signals a shift toward flexible, efficient and reliable grids.

Global Grid Investment by Market (USD Bn)



Source: *Bloomberg*

Top 10 Transactions by Deal Size Within the Last 12 Months

Notable Investments Across Grid, Storage, and Clean-Tech Solutions

Deal Date	Company	Investors	Deal Status	Deal Size (in USD Mn)	Country	Deal Type
17-Mar-25	Greenlink Interconnector	Baltic Cable, Equitix	Completed	1,000	Ireland	Buyout/LBO
25-Jun-25	Takanock	ArcLight Capital Partners , DigitalBridge Group	Completed	500	USA	Buyout/LBO
4-Jun-25	PowerTransitions	Partners Group	Completed	450	USA	Buyout/LBO
6-Oct-25	Urbint	Itron	In Progress	325	USA	Merger/Acquisition
14-Apr-25	Mainspring	DCVC, Gates Frontier, General Catalyst, Khosla Ventures, LGT Bank Austria, Lightrock, M&G,Marunouchi Innovation Partners, Pictet, Temasek Holdings and The Climate Pledge	Completed	258	USA	Later Stage VC
22-Oct-25	Summit Ridge Energy	Crux Climate (Yonette McLean)	Completed	244	USA	Corporate
11-Nov-25	Highview Power	Centrica (LON: CNA) (Christopher O'Shea), KIRKBI, Mosaic Capital, The Goldman Sachs Group (NYS: GS)	Completed	172.4	USA	Later Stage VC
19-Sep-25	TeraWatt Technology	Development Bank of Japan, GK Goh Holdings, GLIN Impact Capital, GX Promotion Agency, Inpex	Completed	96.9	USA	Later Stage VC
31-Mar-25	Omnidian	Activate Capital Partners (Eric Meyer), Alumni Ventures (Matthew Caspari), B Capital Group (Jeffrey Johnson), BNP Paribas, Boston Consulting Group, Citi Impact fund, IA Capital, National Grid Partners, etc	Completed	87	USA	Later Stage VC
23-Oct-25	Asuene	Daikin Industries (TKS: 6367) (Masaaki Miyatake), GLIN Impact Capital (Masahiro Hata), Global Brain, GMO Venture Partners, etc	Completed	76.64	Japan	Later Stage VC

Source: *Aranca Research*

Challenges & Risks in Grid Expansion

Strategic Hurdles in the Multi-Trillion Dollar Opportunity

AGING GRID INFRASTRUCTURE

- **Critical Age Profile:** Average equipment age in key regions is approx. **40 years**, with over **25%** of assets exceeding 50 years.
- **Outage Risks:** Aging transformers and lines heighten failure rates, directly linked to recent incidents like wildfires.
- **Environmental Threat:** Climate change amplifies physical risks; without modernization, companies face soaring maintenance bills and equipment failures.

REGULATORY & PERMITTING HURDLES

- **Timeline Delays:** Planning and approval for high-voltage lines in advanced economies can exceed **10+ years**.
- **Approval Bottlenecks:** Complex environmental reviews, local opposition, and bureaucratic layers significantly slow project deployment.
- **Investment Deterrent:** Uncertain rate-setting frameworks and shifting regulations deter long-term capital commitment.

SUPPLY CHAIN CONSTRAINTS

- **Lead Time Shock:** Average order lead times for HVDC cables have stretched from ~1 year (2020) to **5 years**.
- **Capacity Deficit:** A fourfold rise in annual order volumes has outpaced manufacturing capacity in a concentrated supplier market.
- **Resource Scarcity:** Shortages of transformers, cables, and technical talent are escalating project costs and extending schedules.

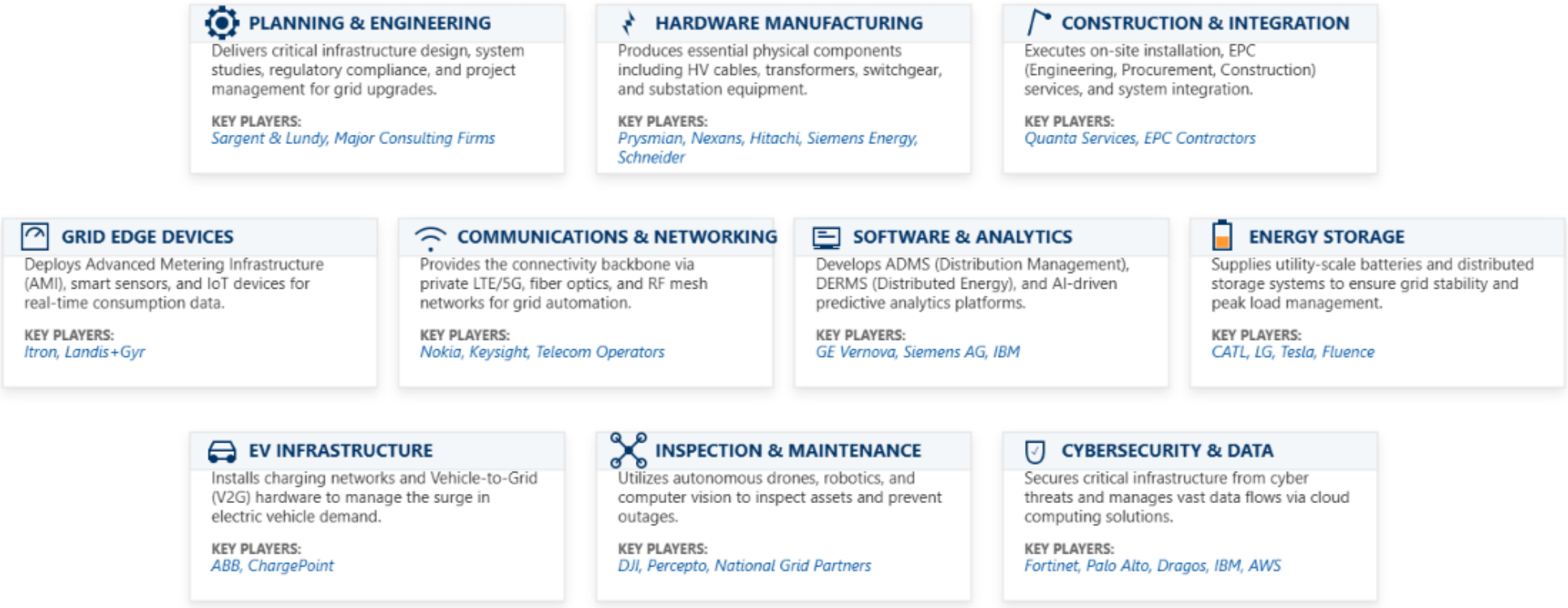
CYBERSECURITY THREATS

- **Rising Attack Surface:** Cyberattacks on energy infrastructure **doubled** between 2020 and 2022 as grids digitize.
- **Critical Vulnerability:** Europe's power sector saw **48 successful attacks** in 2022, highlighting the risk to grid control systems.
- **Mitigation Need:** Preventing blackouts requires robust controls (NERC CIP) and international intelligence sharing.

Who Benefits from Grid Modernization? Supplier's Map

Grid Modernization and smart-grid deployment broadens the supplier ecosystem beyond traditional utility equipment manufacturers.

- The electrification and expansion of global grids create broad investment opportunities across multiple stages of the value chain. From raw materials to advanced equipment and digital solutions, each segment of the supply chain is experiencing rising demand as countries scale up transmission and distribution networks.
- The table highlights that grid modernization creates a wide set of opportunities across the entire supply chain, benefiting companies that provide materials, electrical equipment, digital solutions, and engineering services.



Source: *Aranca Research*

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