America’s Energy Interstate

LAUNCH THE NATIONAL HVDC SUPERGRID

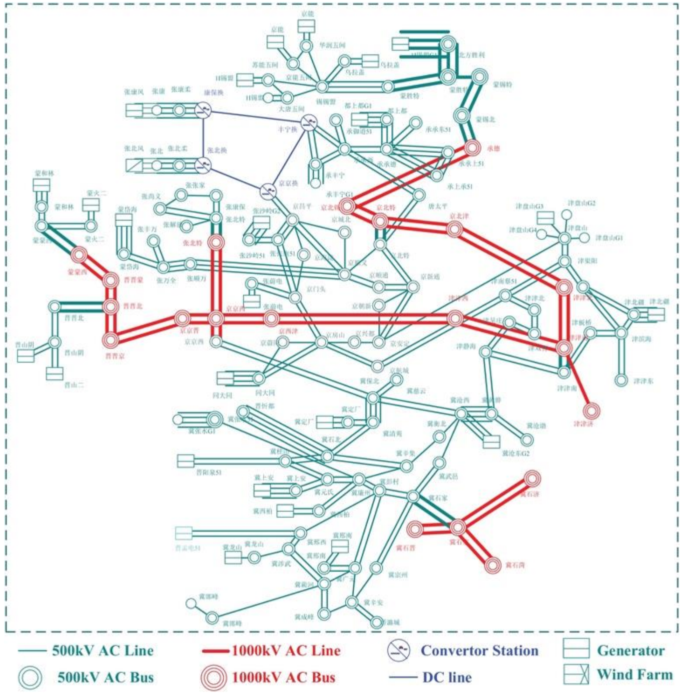
Our Nation's Energy Infrastructure is at risk

- The North American power grid — rightly celebrated as one of the greatest engineering feats of the 20th century — is the invisible backbone of our economy and society. But today, it is operating at the edge of its capacity.
- It was designed over 100 years ago to deliver, at the speed of light, centrally dispatched power to often distant load centers.
- Today it is straining to keep up with:
  - Explosive growth from **AI data centers**, **semiconductor manufacturing**, and **transport electrification**
  - Increasing penetration of intermittent, inertia-less renewable generation at the grid edge
- These growing demands — **combined with escalating threats from cyberattacks and extreme weather** — are placing the nation's energy supply at increasing risk of large-scale disruption.
- ⚠️ The recent **Iberian Peninsula blackout** is a stark reminder of the vulnerability of an aging AC power grid.

Building More Power Plants to accommodate the explosive electricity demand is useless, if the power can't be delivered to the load centers

Our Power System needs a resilient, reliable and efficient transmission grid to bring that power to industrial, commercial and residential customers, at the speed of light.

A Strategic Infrastructure Imperative



- The U.S. power grid was built on **Alternating Current (AC)** technology, which enables efficient transmission of electricity at high voltage over long distances.
- However, AC networks — especially when interconnecting a large number of generators and loads — are **inherently prone to instability**. Events like the **2003 Northeast Blackout** exposed the vulnerabilities of complex, synchronized AC systems.
- Thanks to advances in **power electronics**, a more modern solution has emerged: The **High Voltage Direct Current (HVDC) transmission grid**.
  - HVDC enables **efficient long-distance transmission** (e.g., in China, Canada, and Europe), at a lower cost per mile if over 250 – 300 miles.
  - It offers **lower transmission losses**, **greater stability**, and precise **real-time power flow control**
  - HVDC is ideal for **connecting remote power sources** to load centers and for building **interregional macrogrids**

Restoring American Energy Leadership is crucial to the future of the Country

- The vision for the American Interstate Grid of the Future needs to be developed at the Federal level, in close cooperation with the private sector and the States Agencies.
- American Colleges and Universities are forming some of the best engineers and technicians in the world, but most of those with advanced degrees must go back to their native countries when graduating.
- America lacks the manufacturing facilities, components and trade skills needed to support the development of the HVDC Super Grid.
- President Eisenhower built the Interstate Highway System, a delivery system, to unify a continent and secure America's future in the 20th century.
- President Trump has the opportunity to do the same for the electric grid—by championing the American Super Grid of the 21st Century.

Recommended Presidential Directives

- .Designate the HVDC Super Grid as critical national infrastructure.
- Create a National Economic and Defense Council–led public/private Task Force to oversee the transition to the grid of the 21st Century.
- **Command Full Agency Alignment**
- Enable Federal Backed Private Capital
- Update immigration policies to accelerate the acquisition and retention of power engineers and other critical engineering skills
- Instruct FERC to work with the RTO/ISOs to identify and accelerate approval of priority AC–DC interconnection hubs

MAGGA

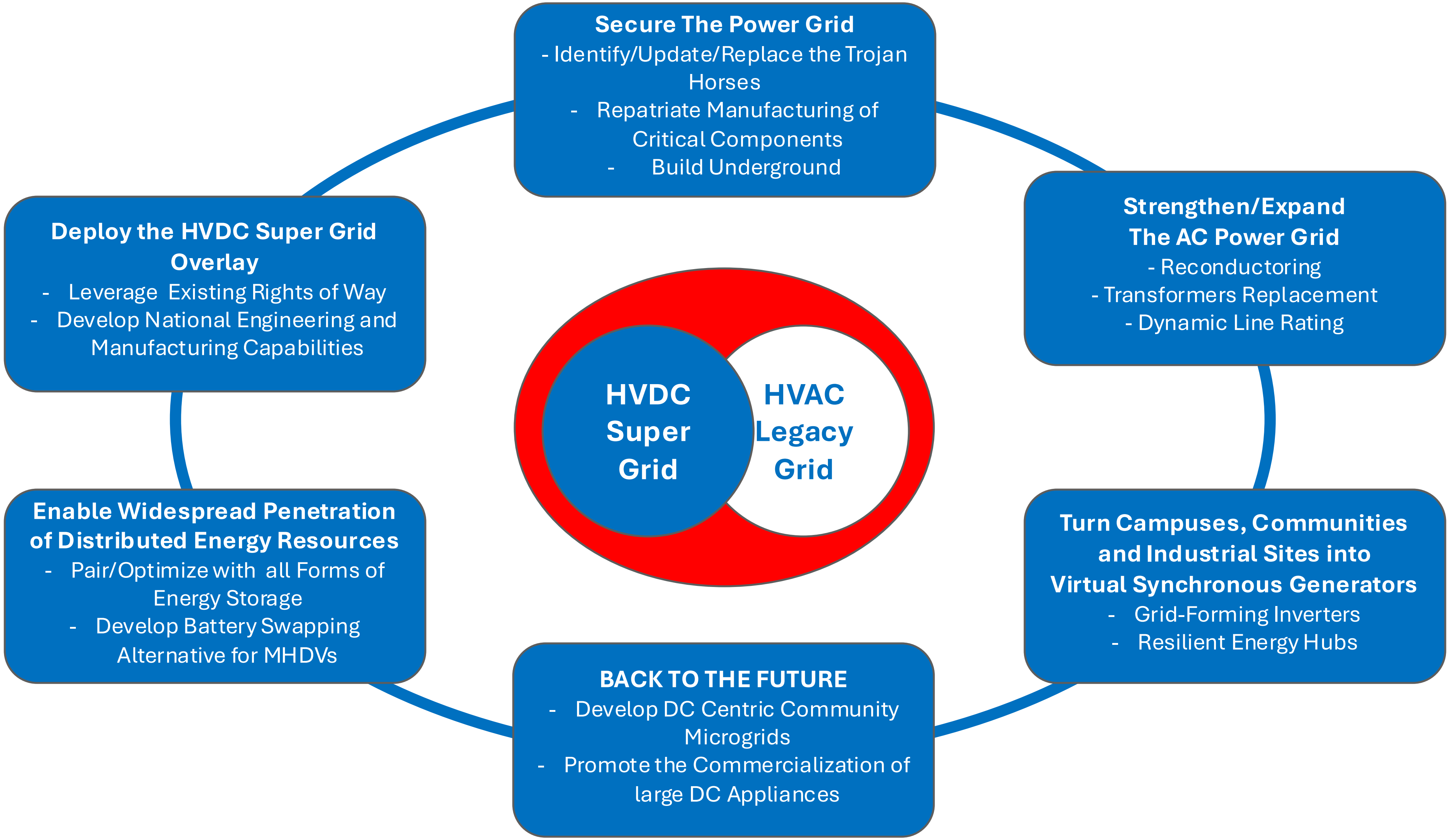
MAKE THE AMERICAN GRID
GREAT AGAIN

Back To The Future

A ROAD MAP TO AMERICA'S POWER GRID

OF THE 21ST CENTURY

The 21st Century American Super Grid
Back-To-The-Future



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AC Power became the de facto standard in the 1890s, because of its ability to be transported efficiently over long distances by stepping up and down its voltage by means of **transformers**.

- Today there are three US power grids connecting power plants to customers: the Eastern, the Western (WSCC) and the Texas interconnections.
- These grids form the backbone of a **complex and coordinated national power system**, serving millions of customers with reliable energy

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The US AC Power Grid

The North American power grid — rightly celebrated as one of the greatest engineering feats of the 20th century — is the invisible backbone of our economy and society.

- Historically, it connects centrally dispatched power plants to the end users through a complex web of high voltage **(Transmission)** and medium to low voltage **(Distribution)** power lines and transformers;
- There are over 3,500 utilities in the US that have been progressively integrated, for reliability and efficiency, into the three US interconnections;

The flow of electricity is controlled by the grid operators. Generally speaking:

- The **Transmission Operator** is responsible for maintaining the system voltage and frequency, by maintaining the supply and demand in balance, every 2 seconds;
- The **Distribution Operator** is responsible for bringing the low voltage power to residential and commercial customers at the right voltage.

All are responsible for keeping the lights on, 24 hours a day

The US Grid capacity is challenged by rapid increases in load demand.

The US Electrical Peak Demand is expected to grow at a 1.2% to 2% annual rate through 2050 (Sources: EIA, NERC, Axios). This is driven by:

- Light weight EV charging: 400 – 700 TWh
- Medium to Heavy Duty Vehicles (MHDV) charging, especially Class 8 Semi-Trailers: 1 to 3.5 MW Mega Charging (MCS)
- Data Centers including AI and Bitcoin Miners: load expected to double by 2030.
- Repatriation of critical semi-conductors manufacturing
- Electrification of Commercial. Industrial and Residential Buildings

Solutions:

- Developing the US HVDC Super Grid to connect renewable generation over long distances,
- Strengthening the Power Grid to accommodate a diverse portfolio of centrally dispatched power sources;
- Distributed Generation/Co-location
- Virtual Power Plants (VPP)

The US Grid reliability is increasingly impacted by renewable generation sources

The deployment of renewable generation at the edge of the grid creates new challenges to the grid operators:

- Intermittency: fluctuates widely based on weather and time-of-day
- Loss of visibility: about 30% of US solar power is generated Behind-the-Meter and not visible to the grid operator;
- Loss of controllability: renewable generation lacks the controllability of traditional generators;
- Bidirectionality: power can flow both ways, in a system planned for unidirectional flows;
- Fast ramping: solar generation decreases at the end of the day, and coincides with the evening peak (California Duck Curve);
- Loss of system inertia: as electro-mechanical generators are replaced with inertia less renewable sources, the power system is losing the inertia, increasing the risk of instability and blackouts.

Solutions:

- Pair renewable generation with all forms of energy storage
- Form microgrids/nanogrids
- Leverage Grid-Forming Inverters to turn them into bidirectional Virtual Synchronous Machines (VSM), providing voltage and frequency control, and injecting synthetic inertia.

Building New Transmission Capacity is a Major Bottleneck

It takes typically 7 to 10 years to build a new high voltage AC transmission line:

- Lengthy Permitting Delays
- NIMBY

Aging Infrastructure creates additional demand for replacement of key components:

- 2,100 high voltage transformers (345, 500 and 765 KV)
- 70% are over 25 years old

Impact of EV Charging:

- Significant reduction in transformer lifespan — from 30 years to less than 10 years — due to sustained high load excursions caused by EV charging.
- Hosting Capacity

Dependence on Foreign Manufactured Equipment

- High Voltage Transformers: 1 to 2 years
- Low to Medium Transformers: 1 year

Solution: Repatriate manufacturing of critical grid components to the US:

- Reduce delivery times, supply chain and security issues;
- Create manufacturing jobs
- Streamline permitting process

The US Grid is increasingly vulnerable to external threats

Some **critical grid components** procured overseas have been compromised in the manufacturing process (Trojan Horses):

- **Solar and Battery Inverters:** Undocumented communication modules (e.g., cellular radios) discovered in Chinese-made inverters (Reuters);
- **Ultra-High Voltage Transformers:** 300 – 500 Chinese-made, some with potential hardware 'backdoors' enabling remote shutdown;
- **Breakers:** rogue communications introduced in the remote-control firmware enable remote monitoring and control;

Cyber-attacks increase in sophistication and impact:

- December 2015 Russian attack on a Ukraine Distribution SCADA

Climate Change:

- Increased frequency and severity of extreme weather events (e.g., heatwaves, wildfires, hurricanes) are damaging grid infrastructure
- Higher average temperatures are driving up peak electricity demand, straining transformers, reducing thermal margins on transmission lines, and increasing the risk of cascading failures

Solution: Decrease vulnerability by decentralization of the power system.

Back To The Future: The Grid of the 21st Century

The US Super Grid of the 21st Century will be a network of regional AC Power Grids interconnected via an Ultra High Voltage DC National Highway.

- .At the regional level, transmission and distribution grids will blend into a meshed, bi-directional distributed network interconnecting centrally dispatched power plants with Distributed Energy Resources (DER) aggregated as dispatchable Virtual Power Plants (VPP) or Virtual Synchronous Generators (VSG).
- Community DC Microgrids will provide City and Suburban housing developments with shared storage, renewable generation and backup generation, leveraging Grid-Forming Inverters to act as island able VSGs.
- Residential, multi-family and commercial buildings electricity networks will be predominantly DC.
- Military and Civilian campuses will become Resilient Energy Hubs

· Grid-forming inverters and synthetic inertia to stabilize high-renewables systems

Recommendation #1: Make the development of the HVDC Power Grid a National Priority

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Recommendation #2: A National Plan to Inspect/Update/ Replace compromised critical grid components

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Recommendation #3: Bring Back the Manufacturing of Critical Grid Components to the US

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Recommendation #4: Retrain and Develop the Next Generation of the US Electrical Worforce

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Recommendation #5: Strengthen the Grid by Turning Military, Industrial and Civilian Campuses into Resilient Energy Hubs

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Recommendation #6: Develop and Deploy Realistic Alternatives to the Electrification of Freight Corridors, Ports and Airports

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Recommendation #7: Turn Community Neighborhoods into DC Powered Virtual Synchronous Machines (VSM)

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- AC Power became the de facto standard in the 1890s, because of its ability to be transported over long distances by increasing the voltage by means of **transformers**.
- Today's power is delivered from the power to the load centers through three complex power grids (Eastern Interconnection, WSCC and Texas) interconnecting utilities and customers.

AC versus DC
A Brief History

Electricity comes in two main types: Alternating Current (AC) and Direct Current (DC).

- **DC Power** was introduced in the **1870s by Thomas Edison**.
  It flows in **one constant direction**—like water through a hose.
  Modern sources: Batteries, solar panels, and electric vehicles.
- **AC Power** was developed in the **1880s by Westinghouse and Tesla**.
  It **alternates direction 60 times per second** (60 Hz in the U.S.).
  Modern use: It's what powers homes, offices, and cities via the public grid.

By the **1890s**, AC became the preferred system because:

- It could **transmit electricity over long distances** efficiently, by
- Voltage could be **easily stepped up or down** using transformers.

America’s Energy Interstate

TRANSMISSION IS THE ORPHAN OF THE POWER INDUSTRY

Modernizing America's Power Grid: A National Imperative

The power grid is the backbone of the modern economy. It must evolve rapidly to meet the accelerating and increasingly complex demands of the 21st century.

- Today, the U.S. grid is a fragmented patchwork of over 3,500 utilities, divided across three loosely connected regional interconnections. Despite 80% of the grid falling under federal jurisdiction, it lacks national planning, coordination, and investment. The grid is not a seamless "copper plate"—it is a constrained and aging network of transmission and distribution lines, plagued by congestion, reliability risks, and growing vulnerability to extreme weather and cyber threats.
- Electricity demand is on track to **double or even triple within the next 25 years**, driven by:
  - The electrification of transportation and heating (EVs, heat pumps, trucks),
  - A surge in energy-intensive data centers and semiconductor fabs,
  - The reshoring of critical industrial manufacturing.
- At the same time, decentralized clean energy resources are proliferating, demanding a flexible, high-capacity backbone to balance supply and demand across vast geographies.

We cannot electrify a 21st-century economy with a 20th-century grid.

Just as China built a national HVDC backbone to power its industrial expansion, the United States must now act with the same urgency and vision. Without decisive federal leadership, we risk falling behind in energy resilience, industrial competitiveness, and national security.

First Meeting of the World's Largest Power Grid Operators

Recognizing these future challenges, PJM convened in 2004 the CEOs of the world's largest power grid operators to establish a new international alliance: the **Very Large Power Grid Operators (VLPGO)**, also known as **GO15**

- **Keynote address** delivered by **U.S. Secretary of Energy Spencer Abraham**
- **Purpose**: To tackle the increasing complexity and reliability challenges of global transmission systems following the **2003 blackouts** in the U.S. Northeast and Italy
- **Initial membership** represented the Americas, the European Union and Asia.
- **Agreement**: CEOs committed to **sharing best practices, operational know-how, and strategic insights**
- **Action**: Formation of **three specialized Working Groups** focused on:
  - **Root Cause Analysis** of major grid cascading events
  - **Early Detection & Mitigation** of system threats
  - **Support for Advanced Technologies** to enhance grid resilience and coordination

China's National Grid Strategy: From VLPGO Insights to Execution

At the second Annual Meeting of the Very Large Power Grid Operators (VLPGO), hosted by the State Grid Corporation of China (SGCC), the company unveiled its strategic roadmap for modernizing and expanding China's national transmission network—much of which incorporated recommendations developed by the VLPGO Working Groups.

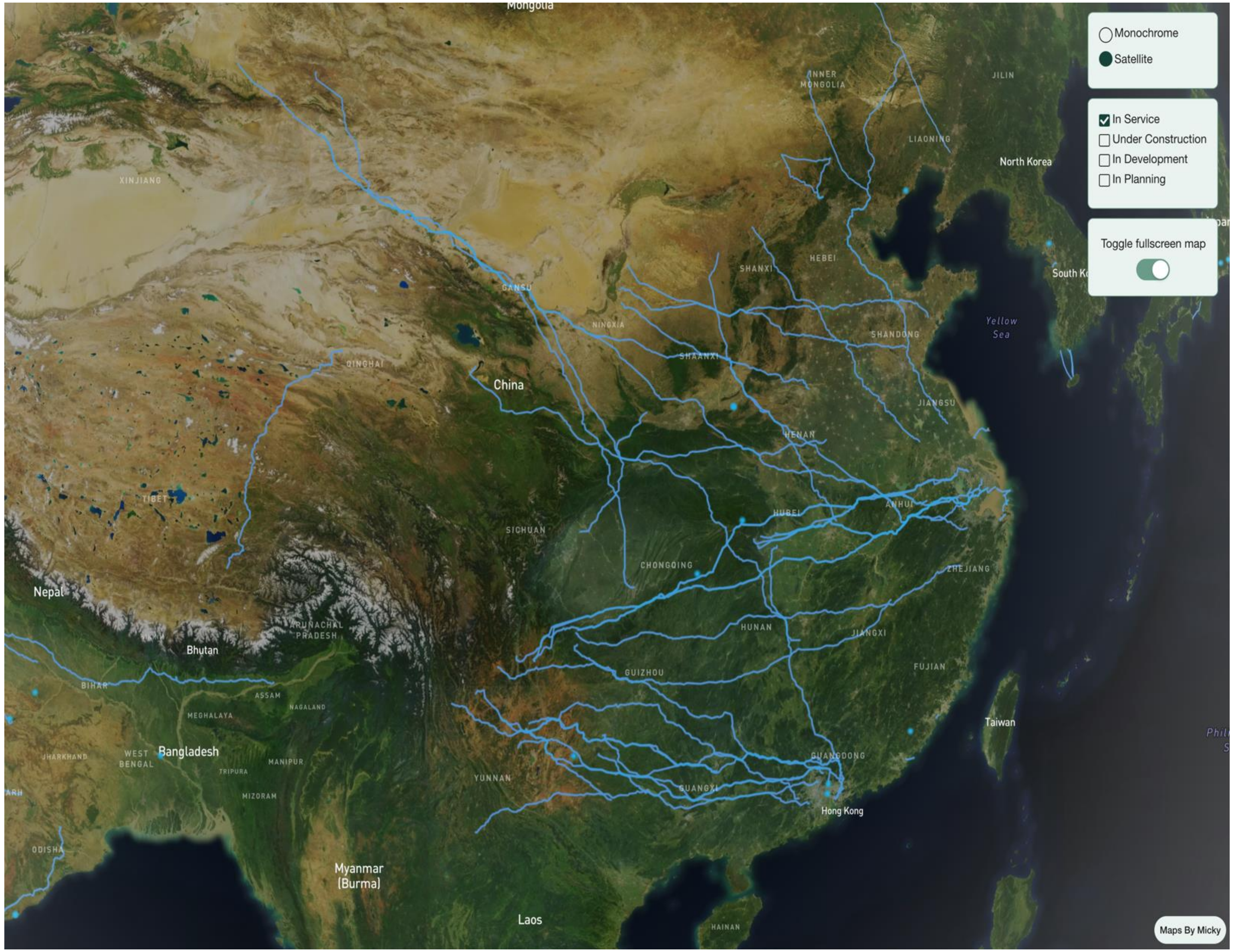
- A cornerstone of SGCC's strategy was the creation of a **national transmission "highway"** to connect coal-rich western regions with the major demand centers along the eastern seaboard. This approach was based on a clear economic rationale: **it is more efficient to transmit electricity than to transport coal** across vast distances.
- Central to this strategy was the deployment of a **High Voltage Direct Current (HVDC) overlay**, enabling lower transmission losses and significantly reduced infrastructure costs compared to traditional AC systems over long distances.
- SGCC also adopted several advanced grid technologies recommended by VLPGO Working Groups, including **wide area real-time monitoring, dynamic stability assessment, advanced computer architecture and enhanced visualization tools** to detect and respond to grid instabilities before they cascade into failures.

Where is China Today

Since the initial VLPGO meetings, SGCC has expanded its transmission capacity by a factor of 20

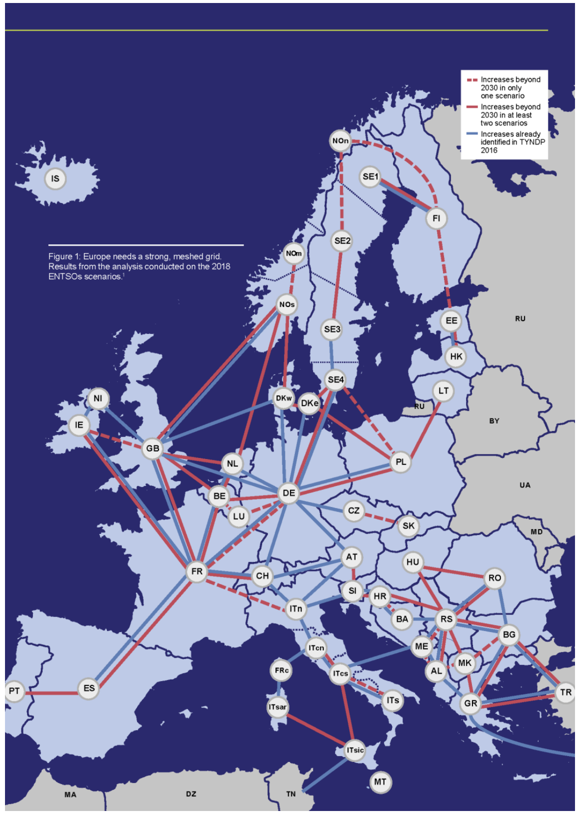
- 1,700 GW of generating capacity equates to the combined output of over 1,700 large power plants and underscores SGCC's scale — it covers ~80% of China's grid
- Its **150 GW Ultra High Voltage transmission capacity** supports long-distance electricity movement across China's vast geography, enabling west-to-east power flows at unprecedented scale
- SGCC continues to expand both generation and transmission — including mega-projects like the 12 GW Zhundong–Wannan ±1100 kV line — to ensure the transmission backbone keeps pace with renewables deployment.

2025 HVDC Networks in Service: China



HVDC Capacity (Operational)	>150 GW
HVDC Line Length	>30,000 km (18,600 mi)
Longest HVDC Line	Zhundong–Wannan: 3,324 km, 12 GW
HVDC Voltage Levels	±800 to ±1100 kV (UHVDC)
Grid Structure	Centralized (SGCC)
Permitting Timeline	<3 years
Federal Planning Authority	Yes
Primary Use Cases	West-to-East Power Flow, Coal Displacement

European HVDC Strategy: Toward a Continental Energy Backbone



- **Strategic Vision**: Europe aims to build an **integrated pan-European electricity market**, capable of balancing variable renewable energy (VRE) across borders. HVDC is central to European decarbonization and energy security goals
- **ENTSOe** coordinates the planning between 35+ countries through its Ten-Year Network Development Plan (TYNDP). It outlines >100 cross-border HVDC projects, supporting:
  - Offshore wind integration (North Sea, Baltic Sea)
  - Solar transport from the South (Spain, Italy, Greece)
  - Grid resilience and congestion relief.
- **Friends of the Supergrid (FOSG)**
  - A coalition of TSOs, OEMs, and policy advocates supporting a “Supergrid”: a meshed HVDC overlay across Europe.
  - The vision includes:
    - Multi-terminal HVDC interconnectors
    - Hybrid AC/DC grids
    - Plug-and-play offshore wind hubs (e.g. Dogger Bank, Bornholm Energy Island)

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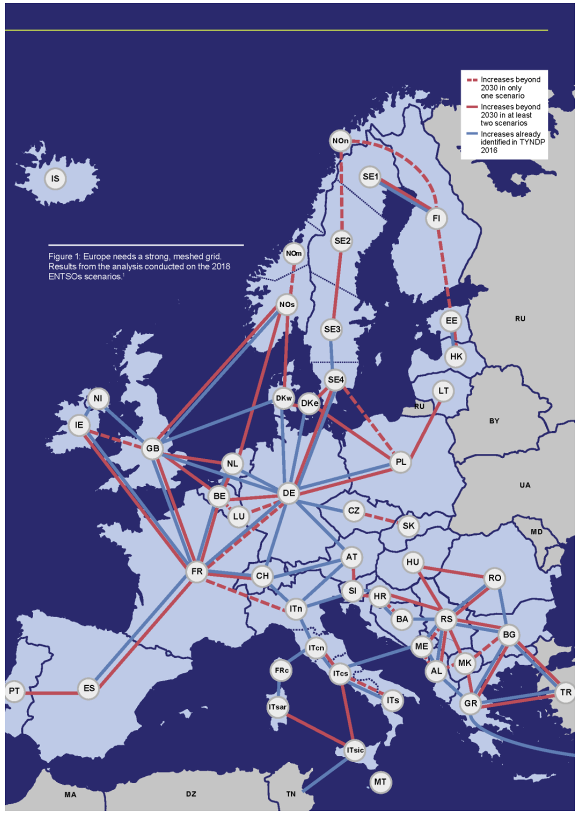


- **Key Projects**
  - **North Sea Wind Power Hub** (NL, DK, DE): Modular offshore platform with multi-country HVDC links
  - **Viking Link** (UK–Denmark): ±525 kV, 1.4 GW, 765 km subsea HVDC cable
  - **Alemán–France–Spain (AFS)** and **Bay of Biscay Link**: Reinforce southern Europe's solar integration
  - **NordLink, NordBalt, and BalticCable**: Connect Nordic hydropower with central Europe
- **Technology**
  - Widespread use of **modular multilevel converters (MMC)** for controllable power flow
  - Deployment of **Grid Forming Inverters (GFI)** for grid stability
- **Policy Drivers**
  - **EU Projects of Common Interest (PCIs)** → fast-track permitting and funding
  - **CEF (Connecting Europe Facility)** and **EIB** → co-finance transmission infrastructure
  - National TSOs coordinated via **ENTSO-E's Regional Groups**

2025 HVDC Networks in Service: Europe

HVDC Capacity (Operational)	~60 GW
HVDC Line Length	~15,000 km (9,300 mi)
Longest HVDC Line	Viking Link: 765 km, 1.4 GW
HVDC Voltage Levels	±320 to ±525 kV
Grid Structure	Coordinated (ENTSO-E)
Permitting Timeline	5–7 years (PCI-supported)
Federal Planning Authority	Yes (EU Commission + ENTSO-E)
Primary Use Cases	Cross-border Wind/Solar Balancing

2025 HVDC Networks in Service: USA

HVDC Capacity (Operational)	~10 GW
HVDC Line Length	<3,000 km (1,860 mi)
Longest HVDC Line	Pacific Intertie: 1,362 km, 3.1 GW
HVDC Voltage Levels	±500 to ±800 kV
Grid Structure	Fragmented (ISOs/RTOs)
Permitting Timeline	7–10+ years
Federal Planning Authority	No
Primary Use Cases	Merchant Projects, Congestion Relief

US is behind in its Grid Infrastructure Modernization

Root Causes: Industry Fragmentation

Regulation

- Multiple regulators, conflicting priorities, and state-by-state approvals slow grid modernization
- Partially deregulated, 50 State Regulators and 9 RTO/ISOs

Utilities

- 3,500+, including 170 Investor-Owned Utilities, 9 Federal Utilities, 2,000 Public Power Utilities, 850 Electric Cooperatives and 200 Power Marketeers
- Local utility incentives not aligned with National Priorities
- Utilities are state-regulated monopolies and largely dominate the regulatory process
- Protectionism against Open Access: utilities can delay new merchant projects, e.g. interstate HVDC line, as they control the interconnection process.

Utilities regulatory model and incentives favor the status quo. Without federal transmission authority or strong incentives, U.S. utilities will continue to slow-walk the national grid modernization

Regulation Impact on Time-Line

China

- **Zhundong–Wannan** ±1100 kV UHVDC (3,324 km, 12 GW): Approved & built in **3 years**
- **National authority (SGCC + NDRC)** → streamlined land acquisition and environmental reviews

Europe

- **Viking Link** (UK–Denmark, 765 km HVDC, 1.4 GW): **5 years** from announcement to construction
- **EU 'Projects of Common Interest' (PCI)** → 3.5-year permitting deadline and single-point authority

United States

- **Grain Belt Express** (Kansas–Indiana): **14+ years** and still in regulatory limbo
- **SunZia** (New Mexico–Arizona): **17 years** to reach construction
- **State-by-state** approvals and litigation lead to long delays

Timeline Improvement with less regulation

China: ±1100 kV Zhundong–Wannan UHVDC line (3,324 km, 12 GW)

- **Timeline:** Planned, approved, and built in **3 years**.
- **How:** State Grid Corporation of China (SGCC) and NDRC have **single-point authority** for siting and permitting across provinces.
- **Impact:** Avoids the need for multiple state/provincial approvals and lengthy public intervention processes.
- **Key Factor:** National priority designation → **fast-track land acquisition**, simplified environmental impact reviews, and integrated grid planning (HVDC routes tied to national energy strategy).

Europe: Viking Link (UK–Denmark, 765 km subsea HVDC, 1.4 GW)

- **Timeline:** 5 years from announcement to construction start.
- **How:** PCI designation provided:
  - Coordinated permitting through **one lead national authority per country**
  - **Mandatory 3.5-year deadline** for final decisions
  - Access to EU funding (Connecting Europe Facility)
- **Impact:** Prevented project from stalling in bilateral disagreements and allowed parallel reviews of environmental/social impacts.

Summary: US Lags in Capacity and Integration

Metric	China	Europe	United States
HVDC Capacity (Operational)	>150 GW	~60 GW	~10 GW
HVDC Line Length	>30,000 km (18,600 mi)	~15,000 km (9,300 mi)	<3,000 km (1,860 mi)
Longest HVDC Line	Zhundong–Wannan: 3,324 km, 12 GW	Viking Link: 765 km, 1.4 GW	Pacific Intertie: 1,362 km, 3.1 GW
HVDC Voltage Levels	±800 to ±1100 kV (UHVDC)	±320 to ±525 kV	±500 to ±800 kV
Grid Structure	Centralized (SGCC)	Coordinated (ENTSO-E)	Fragmented (ISOs/RTOs)
Permitting Timeline	<3 years	5–7 years (PCI-supported)	7–10+ years
Federal Planning Authority	Yes	Yes (EU Commission + ENTSO-E)	No
Primary Use Cases	West-to-East Power Flow, Coal Displacement	Cross-border Wind/Solar Balancing	Merchant Projects, Congestion Relief

The Urgency of Grid Modernization

Unless decisive federal action is taken, the U.S. power grid will increasingly become a **barrier to economic growth** and a **point of national vulnerability**.

- Aging and congested infrastructure will slow the electrification of transportation, manufacturing, and data centers, undermining U.S. industrial competitiveness.
- Fragmented regulatory oversight will continue to delay critical transmission projects, preventing the integration of renewable resources and inflating energy costs.
- The grid will remain highly vulnerable to catastrophic events: extreme weather, wildfires, and cyberattacks could trigger prolonged blackouts with severe economic and security consequences.

Strategic Recommendations

Establish a National Transmission Authority

- Empower a federal body to **plan and coordinate a nationwide HVDC interstate backbone**, similar to the Eisenhower-era interstate highway system.
- Ensure that backbone routes connect renewable-rich regions with major load centers and industrial hubs.

Expand FERC's Federal Mandate

- Grant the **Federal Energy Regulatory Commission (FERC)** clear authority to **fast-track interstate transmission permitting**.
- Set legally binding deadlines for project approvals and limit duplicative state-level reviews.

Realign Utility Incentives with National Priorities

- Revise regulatory frameworks so utilities benefit from **interregional transmission investments**, rather than opposing them.
- Introduce performance-based incentives for **grid resilience, reliability, capacity and national decarbonization targets**.

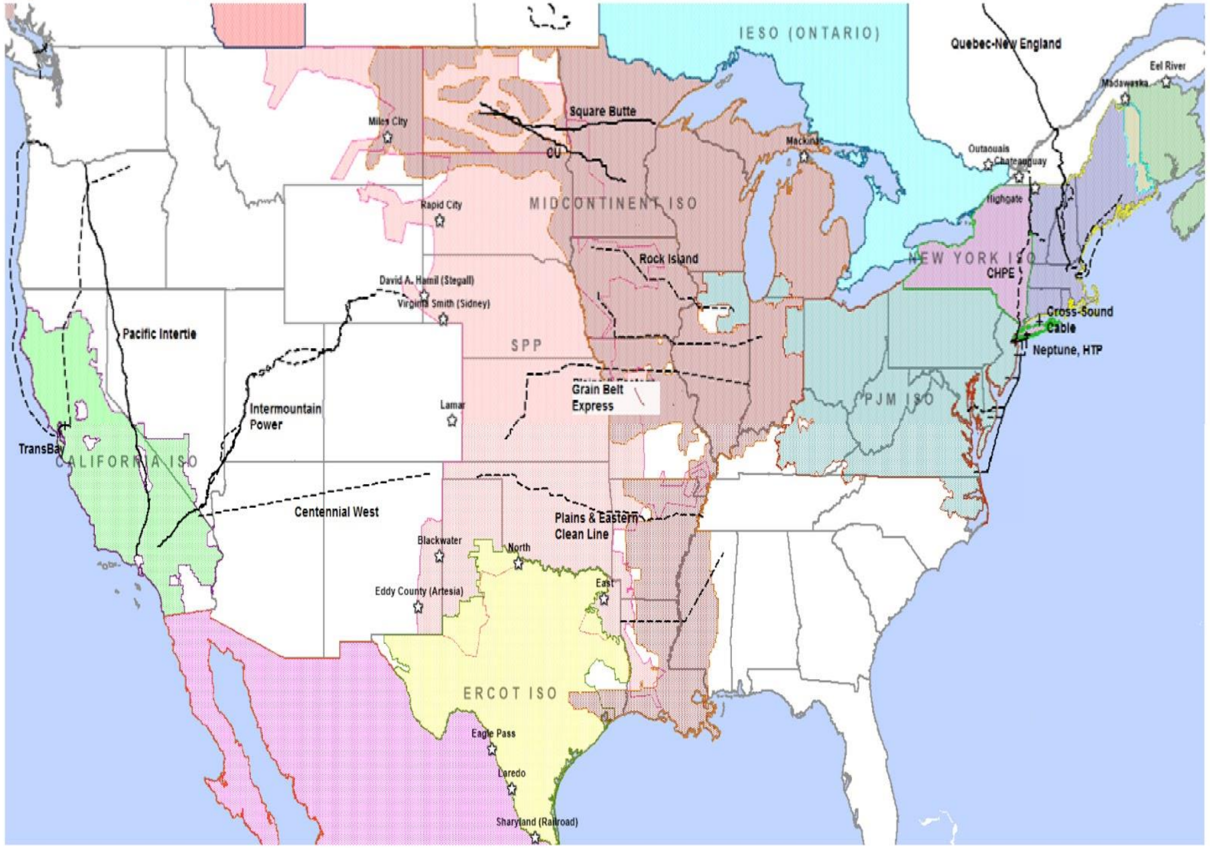
Strengthen Grid Security and Resilience

- Mandate investment in **cyber defense, wildfire mitigation, and climate hardening measures** for critical infrastructure.
- Deploy **advanced grid monitoring and automated controls** to improve situational awareness and response times.
- Turn Distributed Energy Resources (DER) into Advanced Virtual Power Plants, providing grid resilience and reliability services to utilities and RTO/ISOs.

Spares

Today's China UHV Power Grid Capacity is 10x the US Capacity

Figure 1. Existing and planned HVDC lines and interties in North America



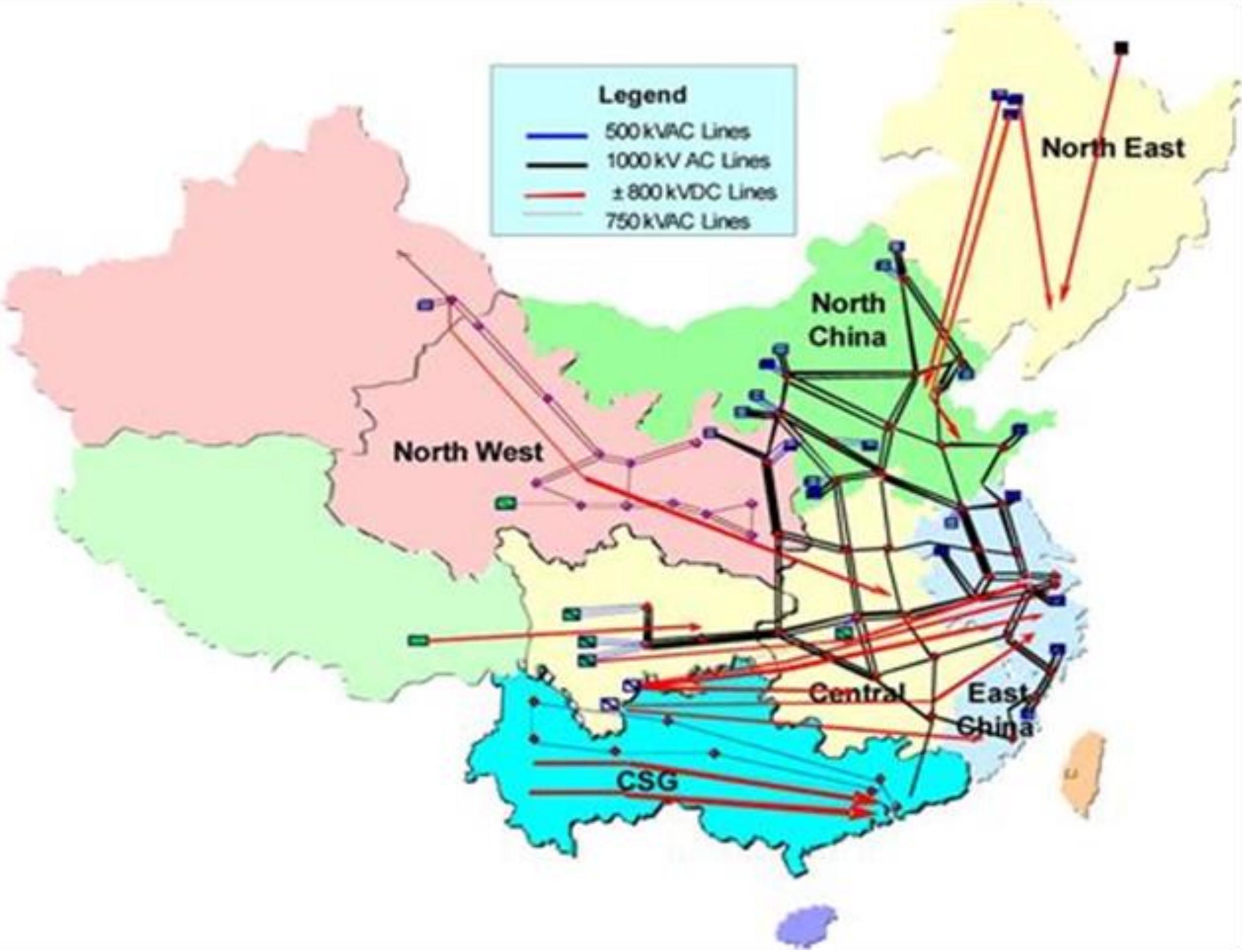
Source: Created by ICF using ABB Velocity Suite Note: Dashed lines represent planned HVDC projects.

USA

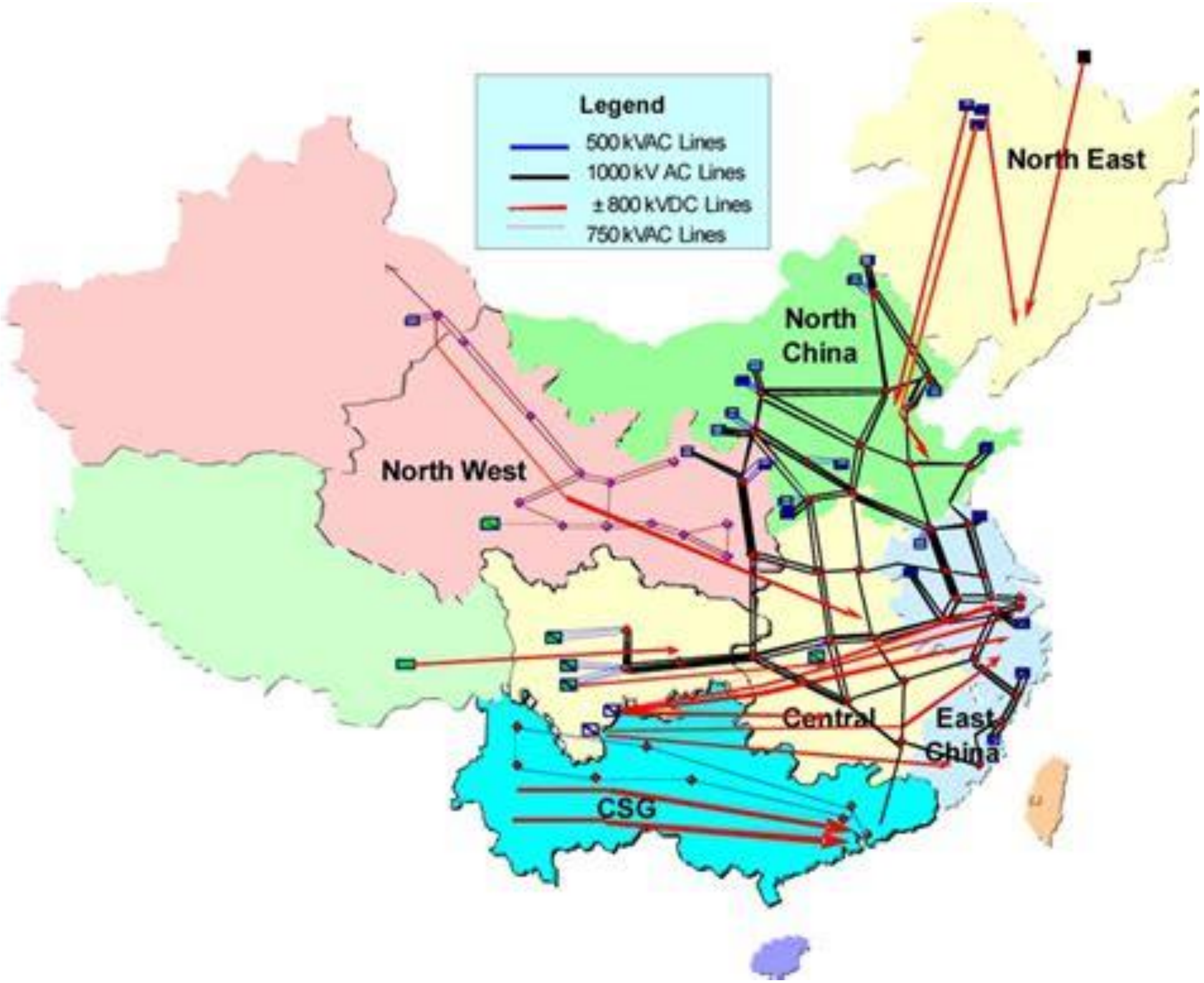
- 1,800 miles of HVDC lines
- 10 projects (500 KV)
- 10 GW Transmission Capacity

China

- Over 18,000 miles of HVDC lines
- 30+ UHVDC lines (±800 kV / ±1100 kV)
- 150 GW Transmission Capacity

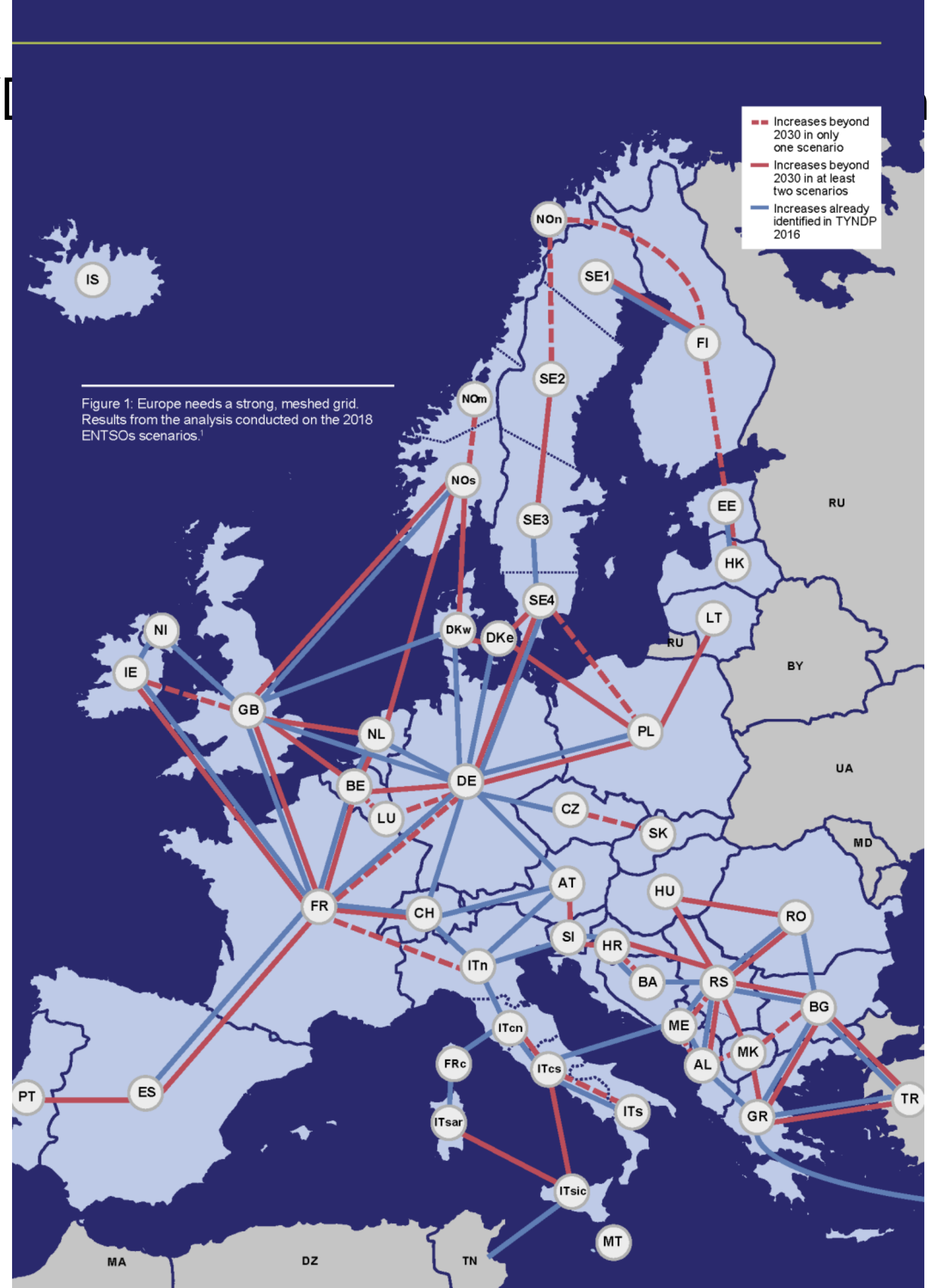


China (SGCC) has developed over the last 20 years a huge Ultra High Voltage (UHV) AC/DC hybrid network



- Over 50,000 km of UHV lines (±800 to ±1100 kV) built or under construction.
- Multi-gigawatt HVDC links connect northwest renewables to eastern megacities.
- Example corridors:
  - Xiangjiaba–Shanghai: ±800 kV, 6.4 GW, ~1,900 km
  - Zhundong–South Anhui: ±1100 kV, 12 GW, ~3,300 km
  - Hami–Chongqing: ±800 kV, 8 GW, 2,260 km (operational June 2025)
- Architecture includes both HVDC & UHVAC for system redundancy and regional balancing.
- Latest VSC-HVDC deployments allow real-time flow control and renewable stability.
- National transmission backbone integrates >85% of generation into the bulk system.

EU European HVD … ergy Backbone



Feature	China (2025)	United States (2025)
Infrastructure	~50,000 km UHV lines (±800/±1100 kV DC + 1000 kV AC) across key resource-to-load corridors	<3,000 km HVDC total; US HVDC mainly via point-to-point merchant links (e.g., Pacific DC Intertie)
Network Topology	Fully integrated national mesh, multiple interregional DC links, hybrid AC/DC grid	Fragmented system with isolated HVDC projects; lack of coordinated backbone
Control & Flexibility	Widespread use of VSC-HVDC, real-time flow control, redundancy across regions	HVDC systems lack full networked control; primarily single-purpose, corridor-limited
Renewable Integration	Optimized for large-scale wind/solar exports from remote western provinces	HVDC lines mainly connect isolated renewables; not designed for grid-wide balancing
Planning & Deployment	Centralized, rapid buildout achieved in 3–5 years per corridor	Permitting and siting take 7–10+ years; no federal strategic coordination

Metric	🇨🇳 China	🇪🇺 Europe	🇺🇸 United States
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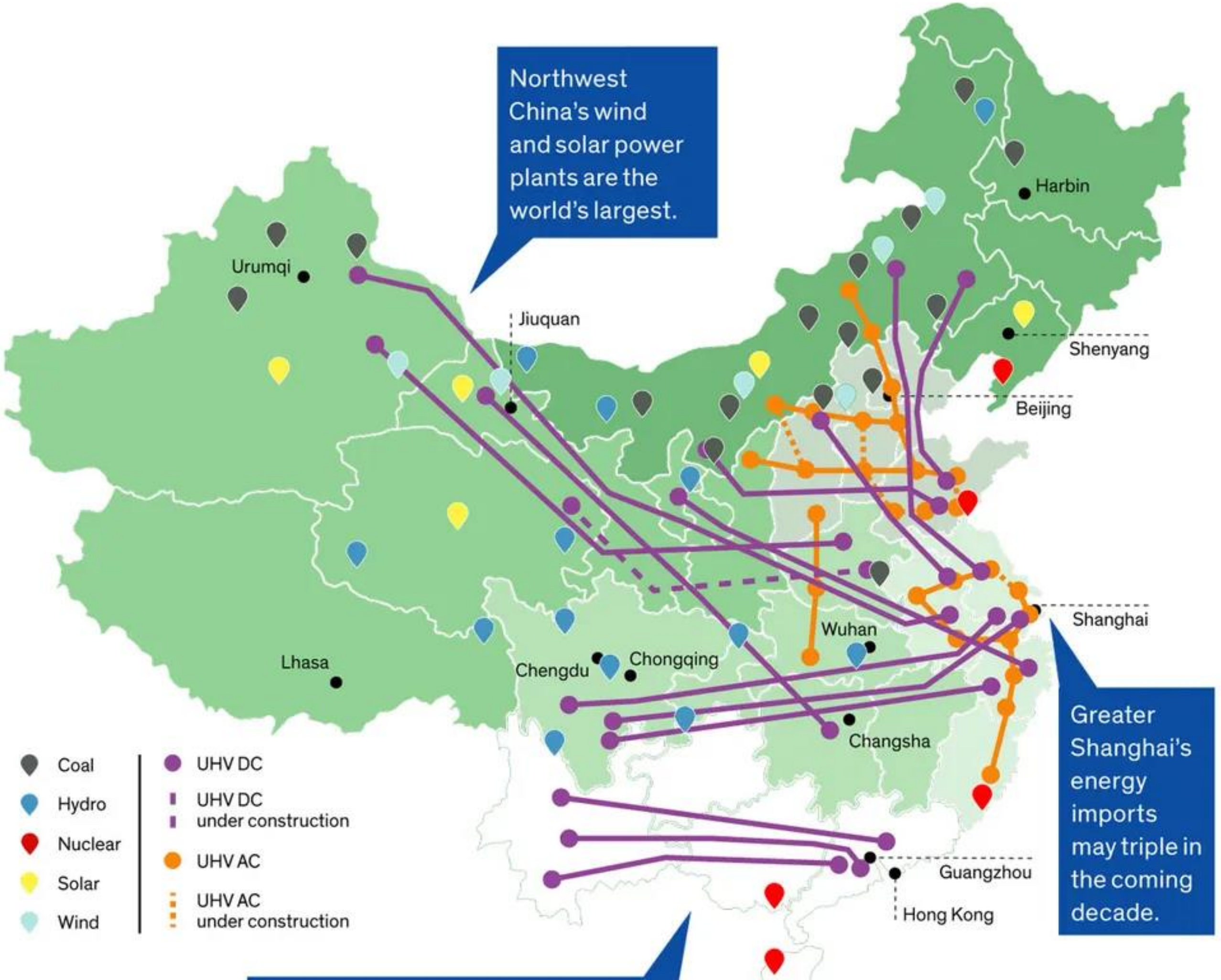
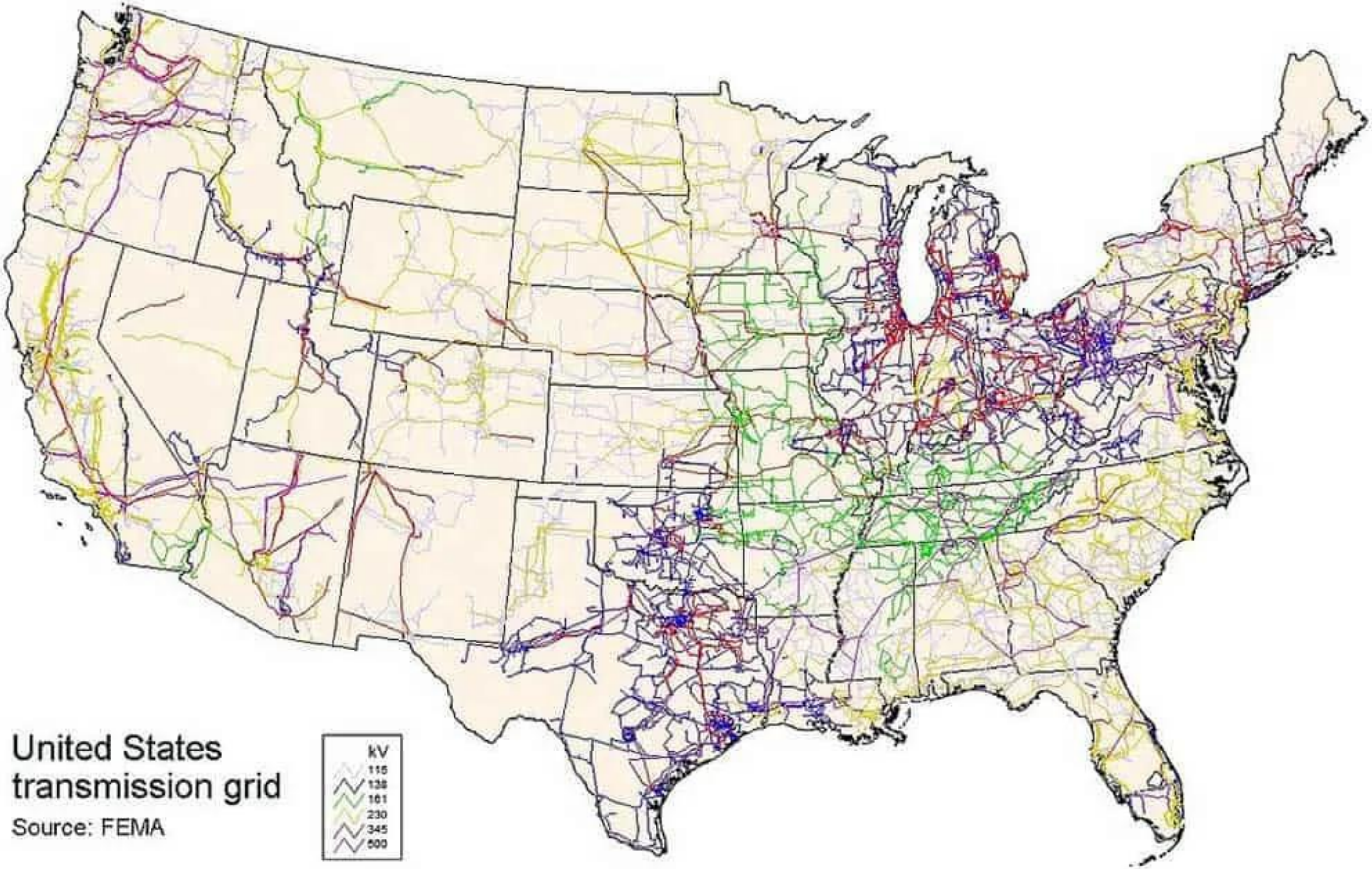
China HVDC Overlay

One VLPGO member, the State Grid Corporation of China hosted the second Annual Meeting of the VLPGOs.

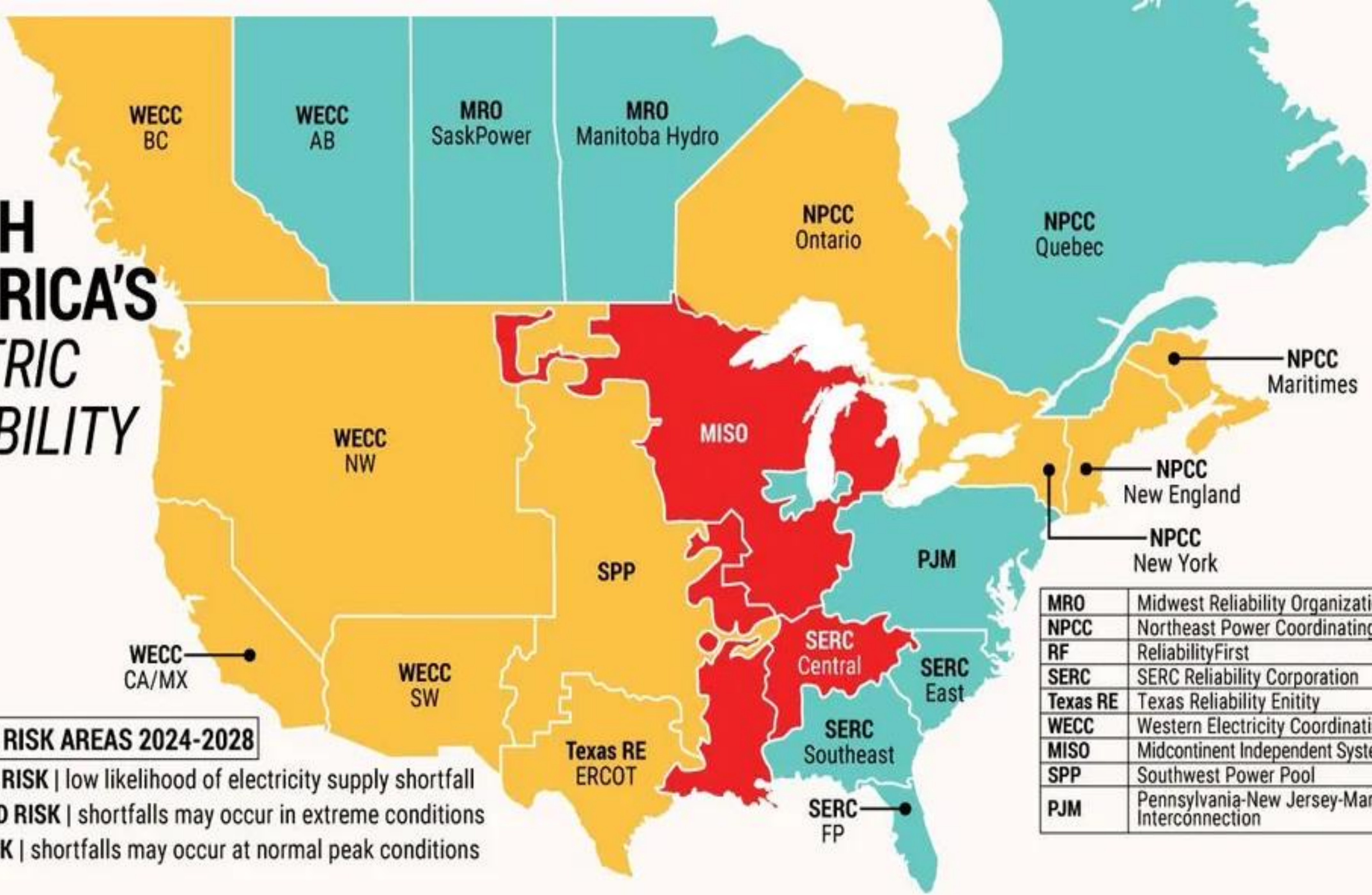
- Keynote





United States transmission grid
Source: FEMA

NORTH AMERICA'S *ELECTRIC RELIABILITY*



PROJECTED RISK AREAS 2024-2028

- **NORMAL RISK** | low likelihood of electricity supply shortfall
- **ELEVATED RISK** | shortfalls may occur in extreme conditions
- **HIGH RISK** | shortfalls may occur at normal peak conditions

MRO	Midwest Reliability Organization
NPCC	Northeast Power Coordinating Council
RF	ReliabilityFirst
SERC	SERC Reliability Corporation
Texas RE	Texas Reliability Enitity
WECC	Western Electricity Coordinating Council
MISO	Midcontinent Independent System Operator
SPP	Southwest Power Pool
PJM	Pennsylvania-New Jersey-Maryland Interconnection