A Reliable Grid for an Electric Future

NEMA's Grid Reliability Study

According to a study conducted by PA Consulting prepared for NEMA, "A Reliable Grid for an Electric Future," January 2025.

Introduction

NEMA's Grid Reliability Study

America's electrical system faces dramatic changes over next 25 years

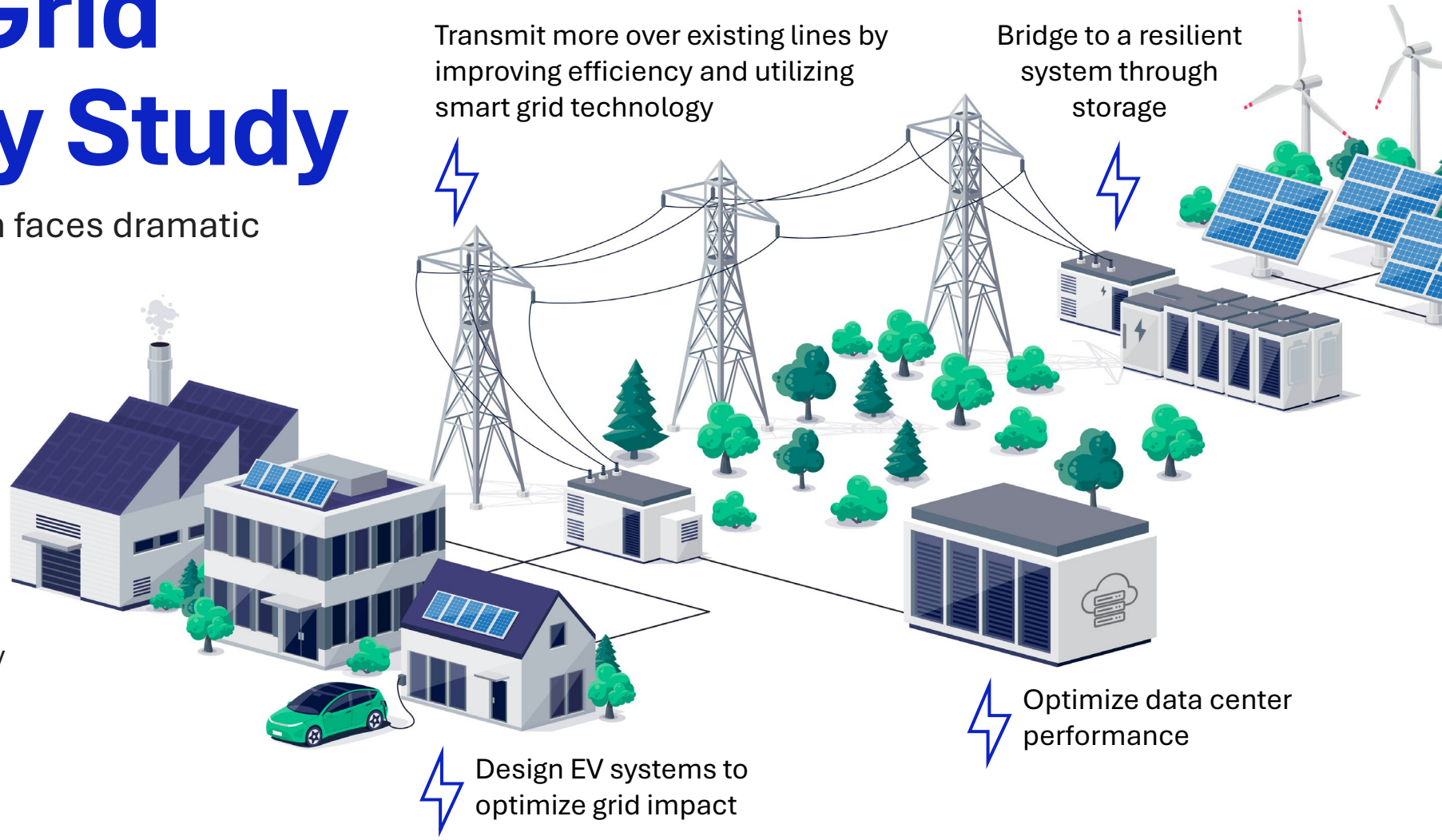
Increased Demand

Electricity demand will grow by more than 50%

New Policies

Critical new policies and regulatory certainty are needed to deliver a flexible, stable, more resilient grid

Urgent need to invest in technologies to meet coming demand in an all-of-the-above energy ecosystem



Executive Summary

America’s electrical system faces dramatic changes over next 25 years

Unprecedented Growth in Electricity Demand Through 2050

Electricity demand will grow >50%

Innovative Technologies Are Essential to Meet Near-Term Demand Surge

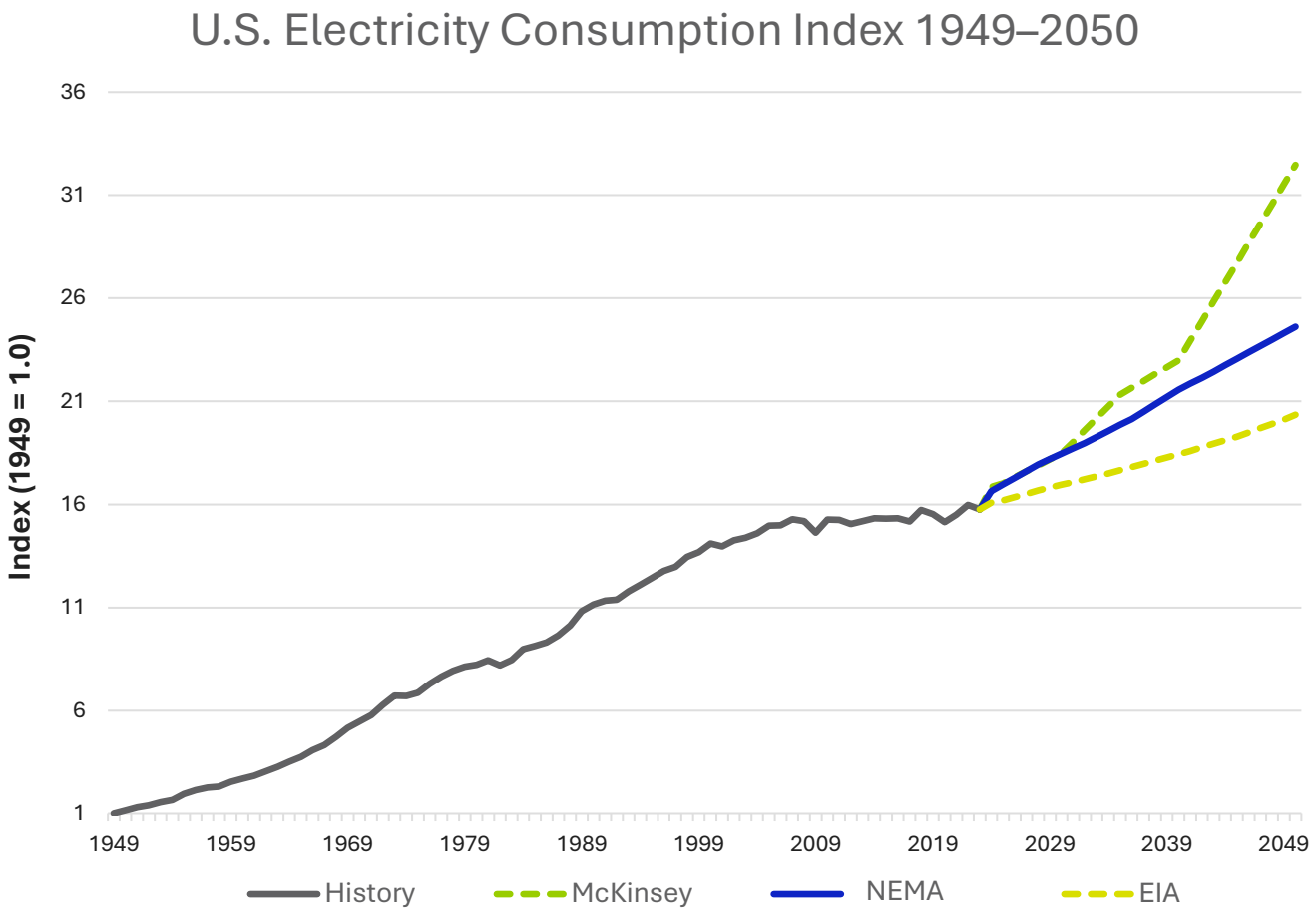
Urgent need to invest in technologies to meet coming demand in an all-of-the-above energy ecosystem

Policy Instruments Must Support America’s Energy System

Critical new policies and regulatory certainty needed to deliver a flexible, stable, more resilient grid

Demand Outlook

Electricity Demand Surges Through 2050



Electricity consumption is projected to grow in unprecedented ways

- **300%** projected growth in data center energy consumption over next 10 years
- **9000%** projected growth in E-mobility power consumption through 2050
- Electricity projected to grow from 21% of final energy use to **~32% by 2050**

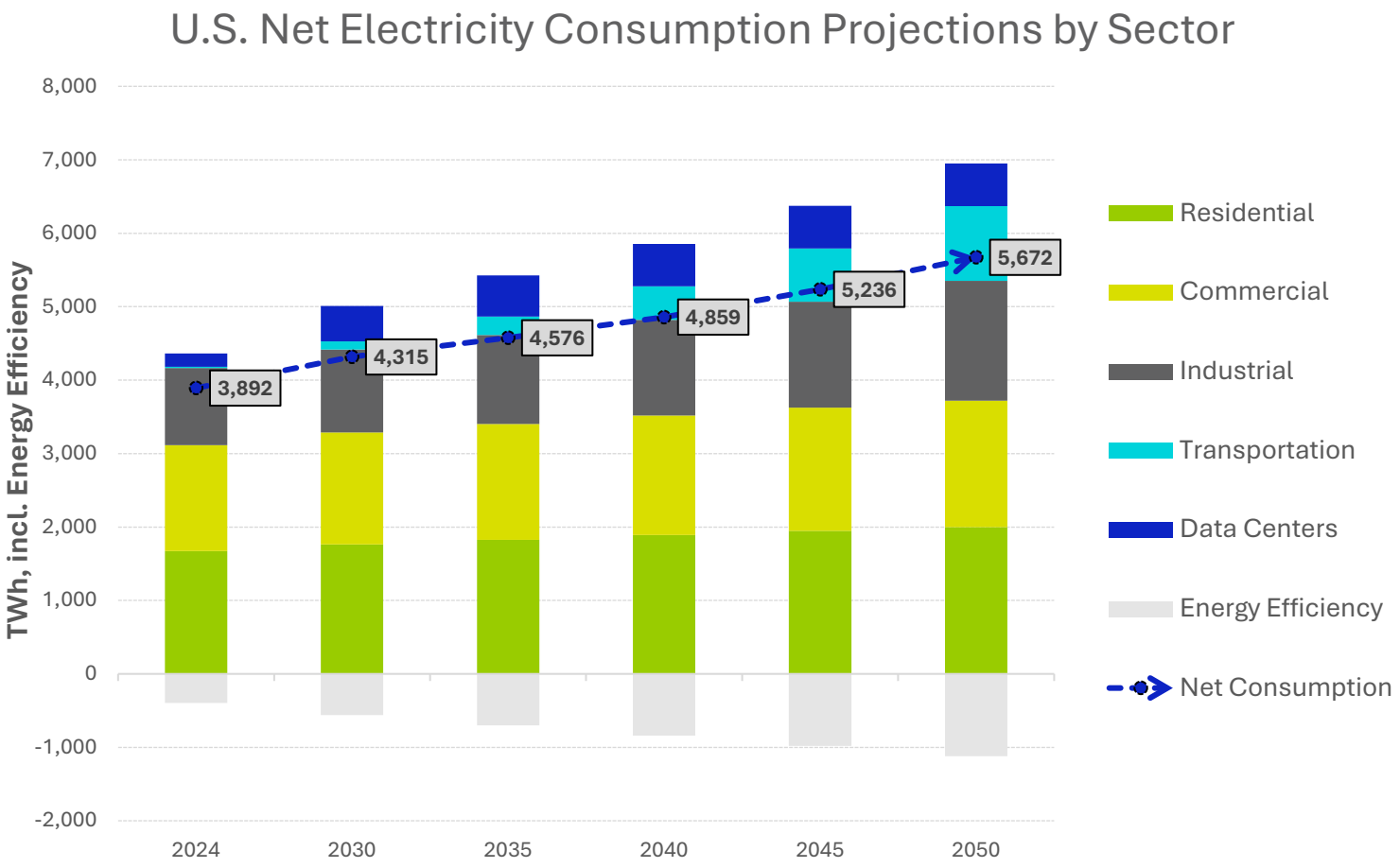
Regionality in generation and consumption adds complexity

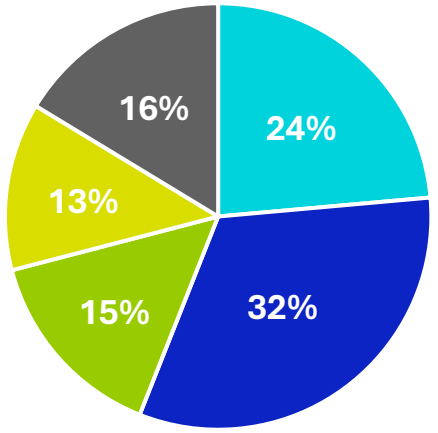
- Mid-Atlantic and Texas will see largest **data center** electricity demand growth through 2035
- Northeast and West will experience largest electricity demand growth from **EVs** through 2050
- Storage, wind, and solar generation will increase by **300%**
- Renewables will **exceed 50% of generation** capacity in Western U.S., New York, and Southeast

Adoption of new technologies and supporting policies needed to meet demand growth

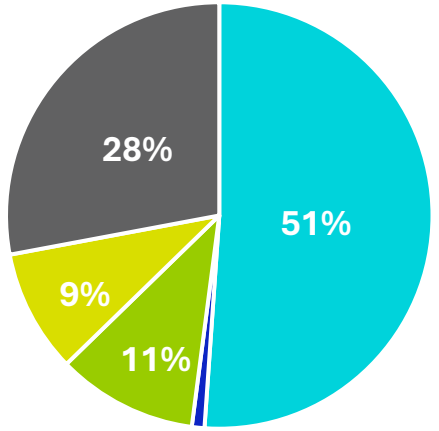
Demand Outlook

Data Centers, then Transportation Lead Demand Growth





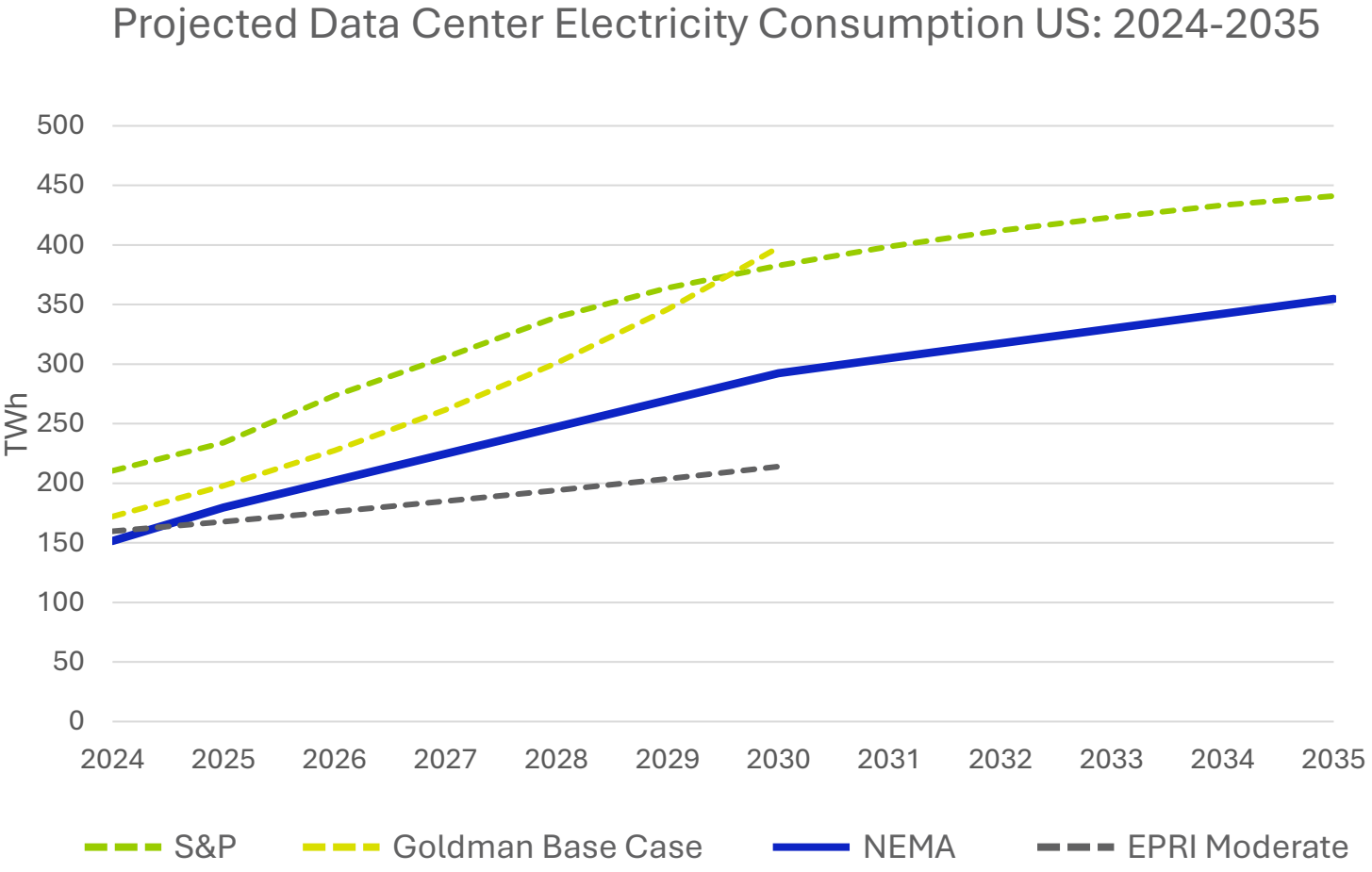
1,323 TWh of Growth by Sector
(2023 to 2037)



1,360 TWh of Growth by Sector
(2038 to 2050)

Demand Outlook

Data Centers Lead 10-Year Electricity Demand Growth



Reliable Baseload Necessary to Meet Data Center Demand

AI Energy Demand Accelerating Load Growth
AI demand a quarter of data center load by 2030

Growth Uncertainty
The pace and scale can vary by region, technological advancements, and shifts in IT strategies

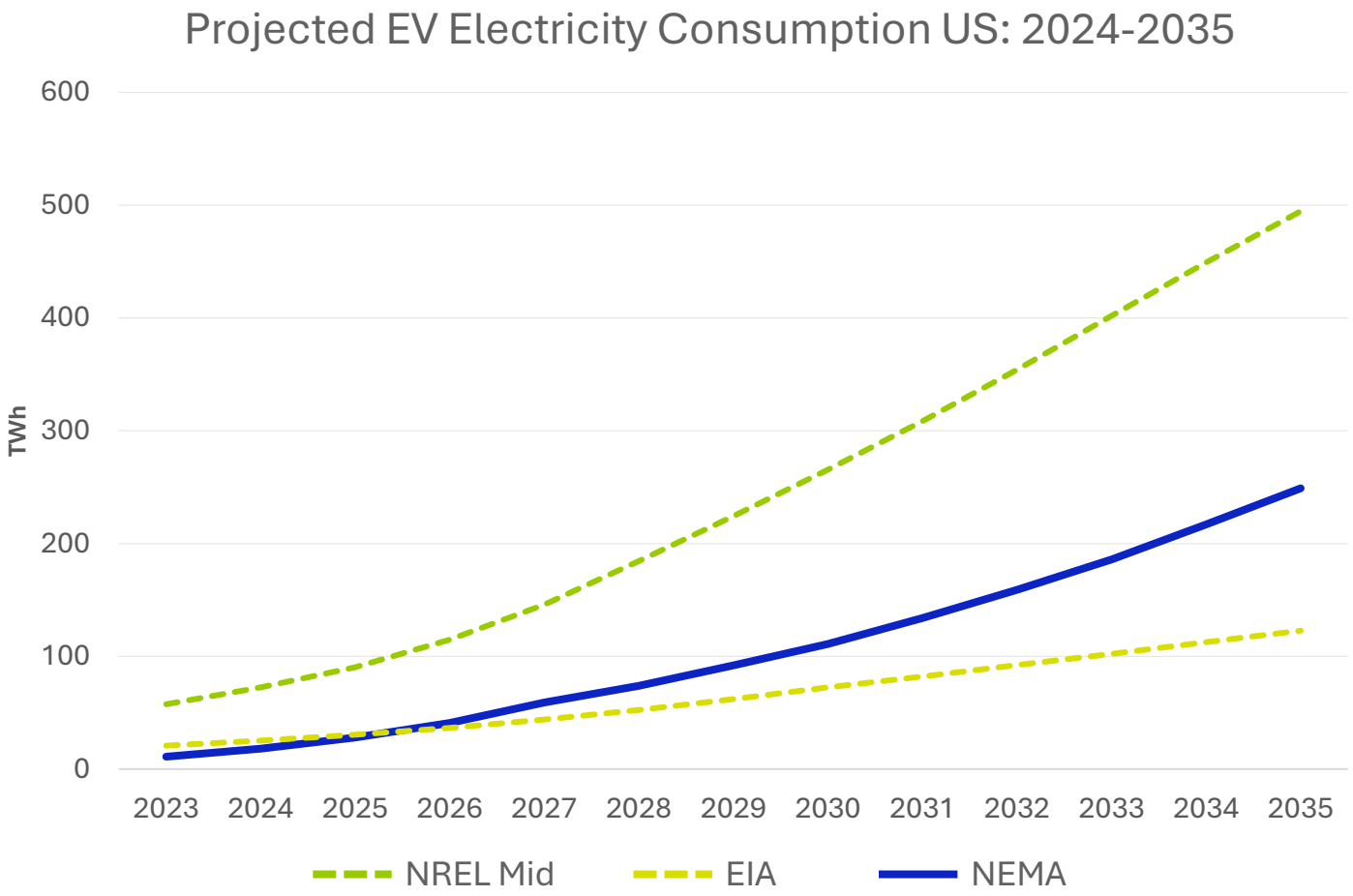
Digital Transformation
Rapid shift in increased cloud adoption is fueling data storage and processing capabilities

Reliable Power Supply Needed
Some AI and machine learning require 10x traditional demand

Security and "Must-Run" Operations
Investments in infrastructure due to rising ncerns about data breaches, physical and cyber curity, and business continuity

Demand Outlook

EVs Second Largest 10-Year Electricity Demand Driver



Policy, Tech Innovations, and Lower Costs Drive EV Adoption

Steady Light-Duty EV Growth

NEMA anticipates ~55 million light-duty EVs on the road by 2035

State Transportation Policy Driving EV Adoption

States comprising 30% of new car sales have adopted California's Zero Emissions Vehicle regulations

Increased Public Charging Access

Federal and state charging programs could increase charging infrastructure across all states, lowering charging anxiety

Technology Transformation

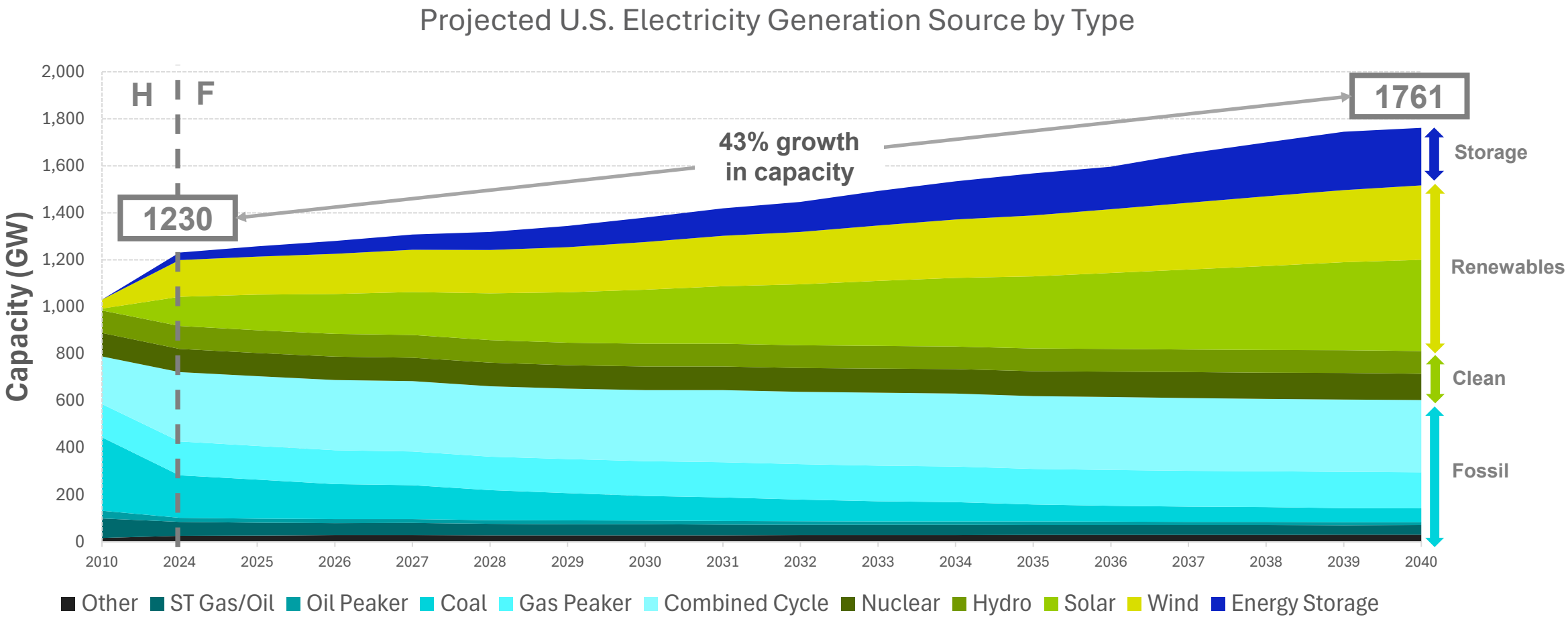
Technology improvements like battery range and vehicle autonomy could rapidly increase adoption

Reduced Costs of Technology

Lithium-ion battery costs have declined by >80% since 2013, and are projected to keep declining

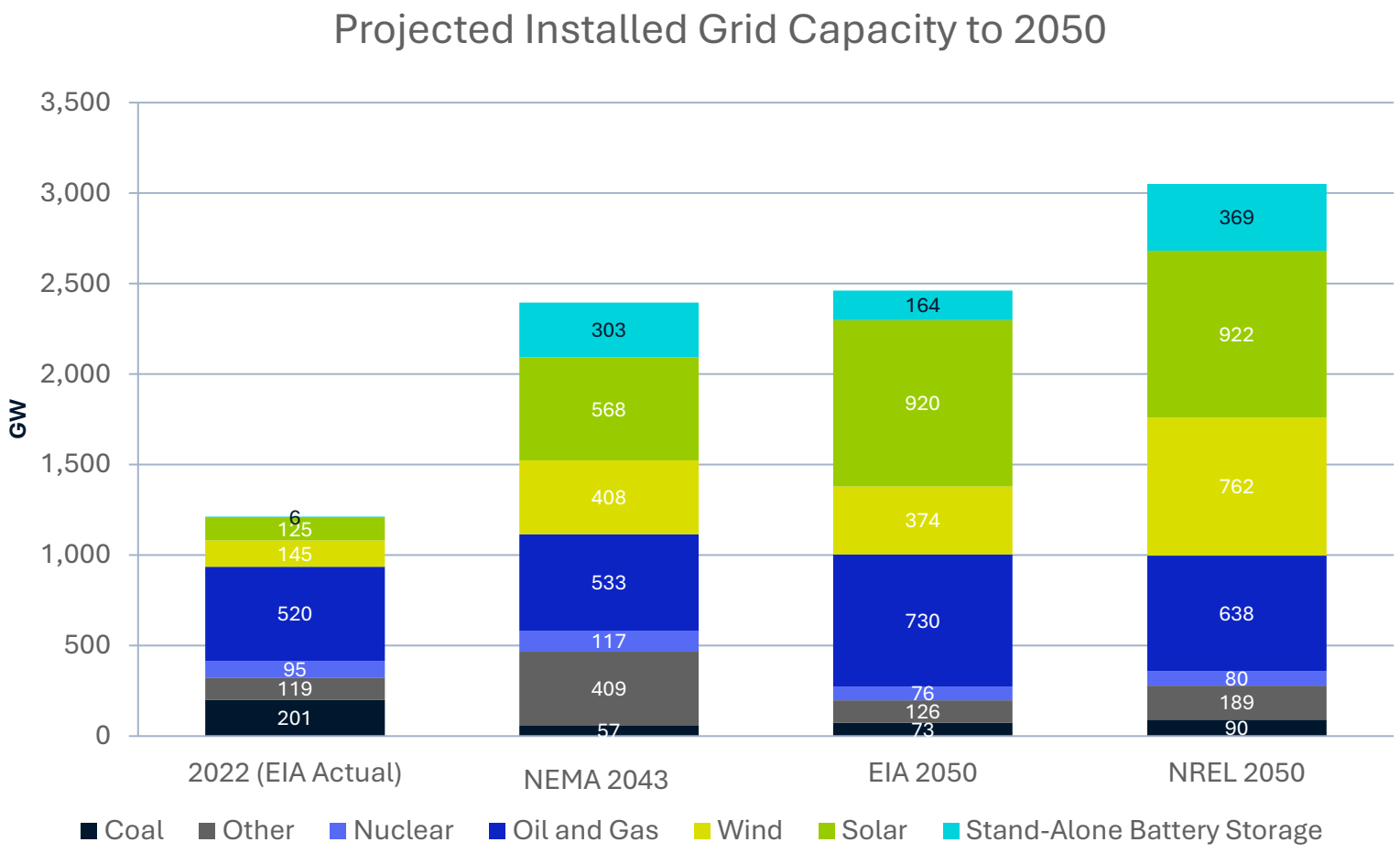
Generation Outlook

Seismic Change in Grid Generation Mix



Generation Outlook

Increased Intermittent Sources Requires Higher Baseload Capacity



Reliable Baseload Generation Needed

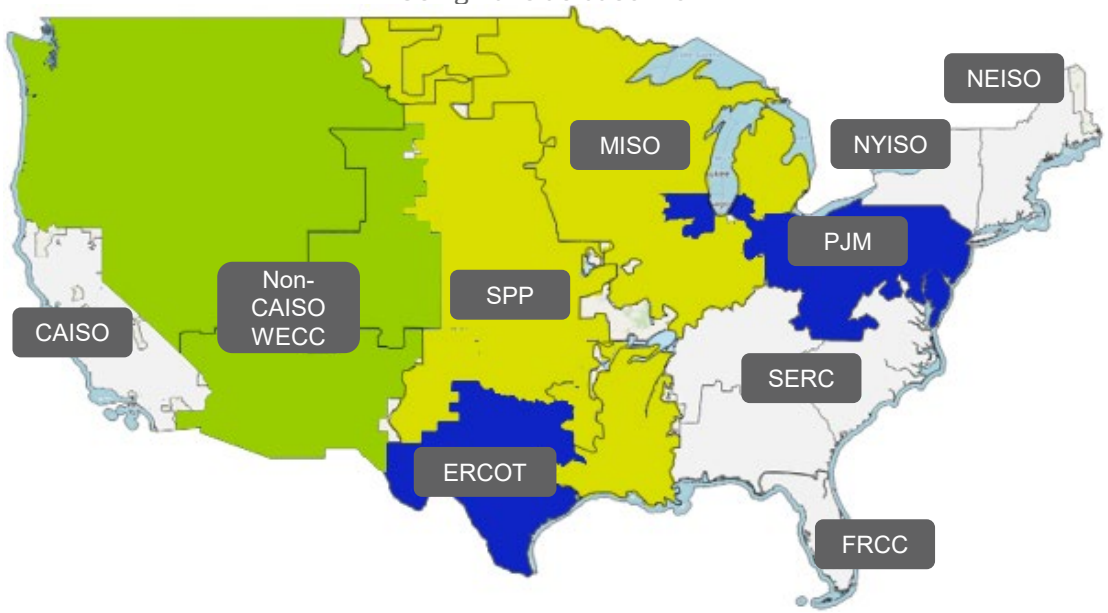
- Wind and solar have capacity contributions of 30% and 10%, respectively, while natural gas has close to 80%.
- Greater share of intermittent must be built to meet demand.
- New intermittent capacity will need to meet current total grid capacity.

Regional Consumption and Demand

Consumption changes will vary by region, driven primarily by data centers in the short term and EVs in the long term

2023-2035 Electricity Consumption Growth

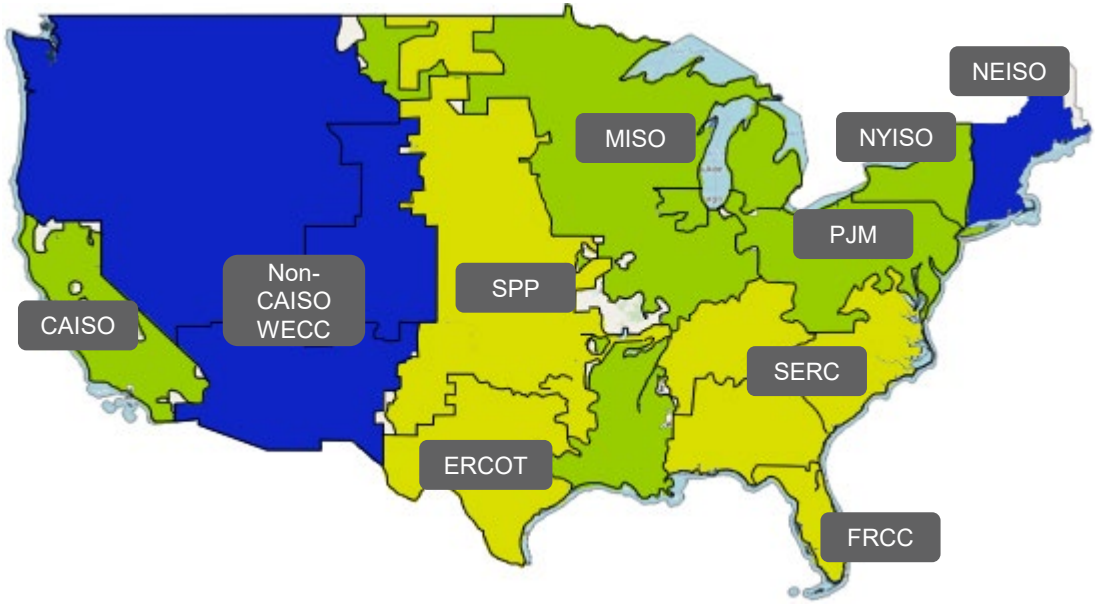
Using 2023 as baseline



- PJM, ERCOT experience the fastest growth (>40%), driven predominantly by data center proliferation
- CAISO and the Southeastern U.S. experience the slowest growth (few data centers, mature energy efficiency initiatives, etc.)

2035-2050 Electricity Demand Growth

Using 2035 as baseline



- EVs drive large changes demand growth in regions like non-CAISO WECC and NEISO, which have lower baseline electricity consumption, yet high projected EV energy demand
- Initially fast-growing regions (ERCOT, PJM) slow down, as data centers saturate

0-10%	10-20%	20-30%	30%+

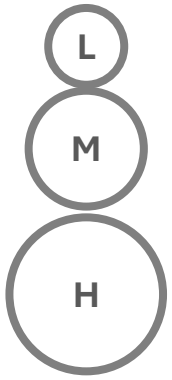
Technology Solutions

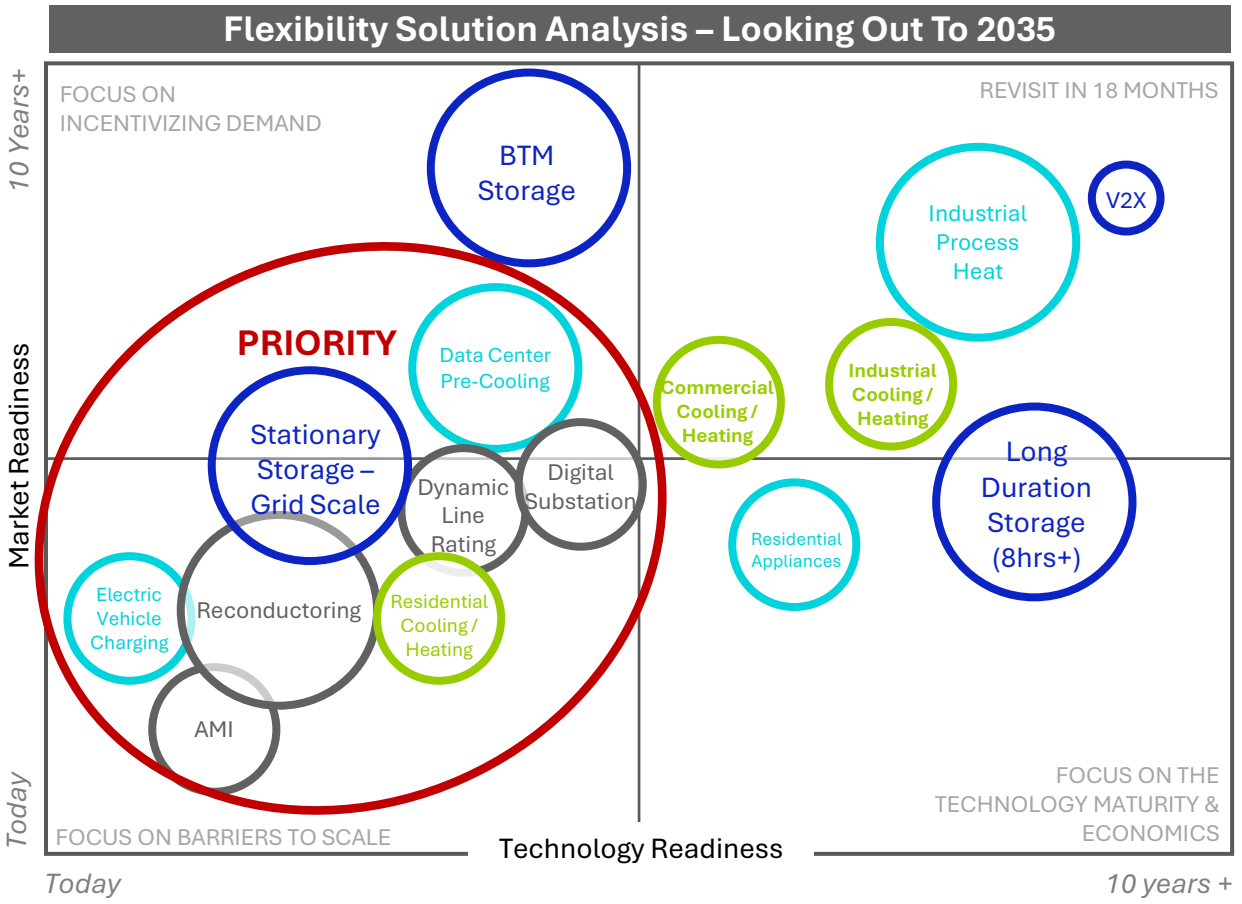
Innovative Technologies Unlock Hidden Capacity

Flexibility Type

- Modernize wires
- Reduce consumption
- Shift consumption
- Store supply

Market Growth Potential to 2035





Transmit More Over Existing Lines

- Improve transmission efficiency and reduce power losses by upgrading lines (reconductoring, **110 GW grid capacity;** dynamic line rating**, 80 GW capacity relief**)
- Deploy smart grid tech to manage supply and demand (digital substations, advanced metering infrastructure, **25 GW capacity relief**)

Optimize Data Center Performance

- Deploy energy-saving and peak-shifting technologies
- Leverage pre-cooling, storage, and microgrids to reduce grid impact, improve reliability, and reduce costs

Bridge to a Resilient System via Storage

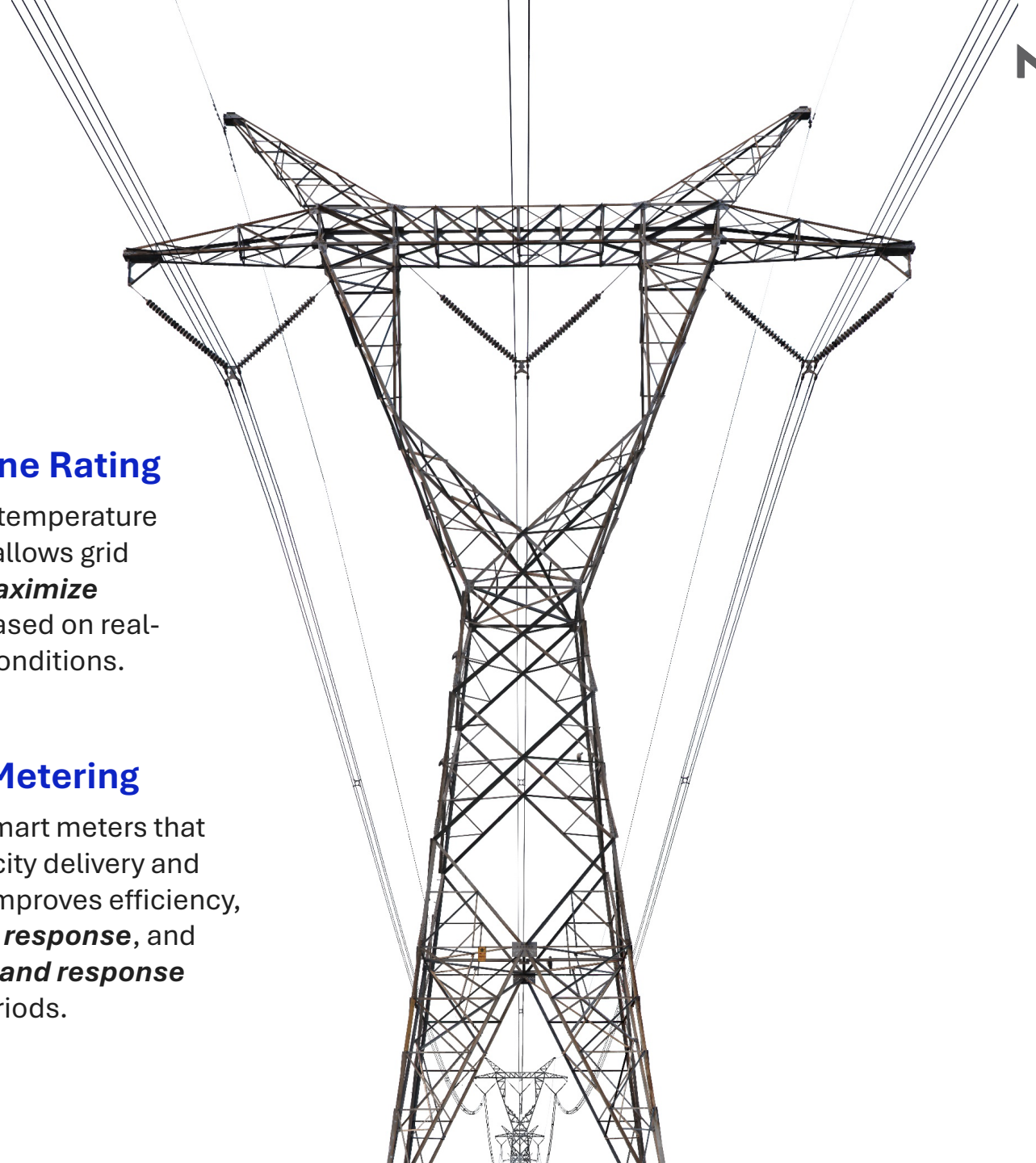
- Enhance grid stability by storing excess energy for use during peak demand (**75 GW transmission capacity**)

Design EV Systems to Optimize Grid Impact

- Use EVs as mobile energy assets to balance supply and demand
- Optimize smart charging and demand shifting to reduce grid stress

Technology Solutions

Transmit More Over Existing Lines



Reconductoring

Replacing existing power lines with advanced conductors can quickly ***boost capacity*** by reducing sag and increasing efficiency.

Dynamic Line Rating

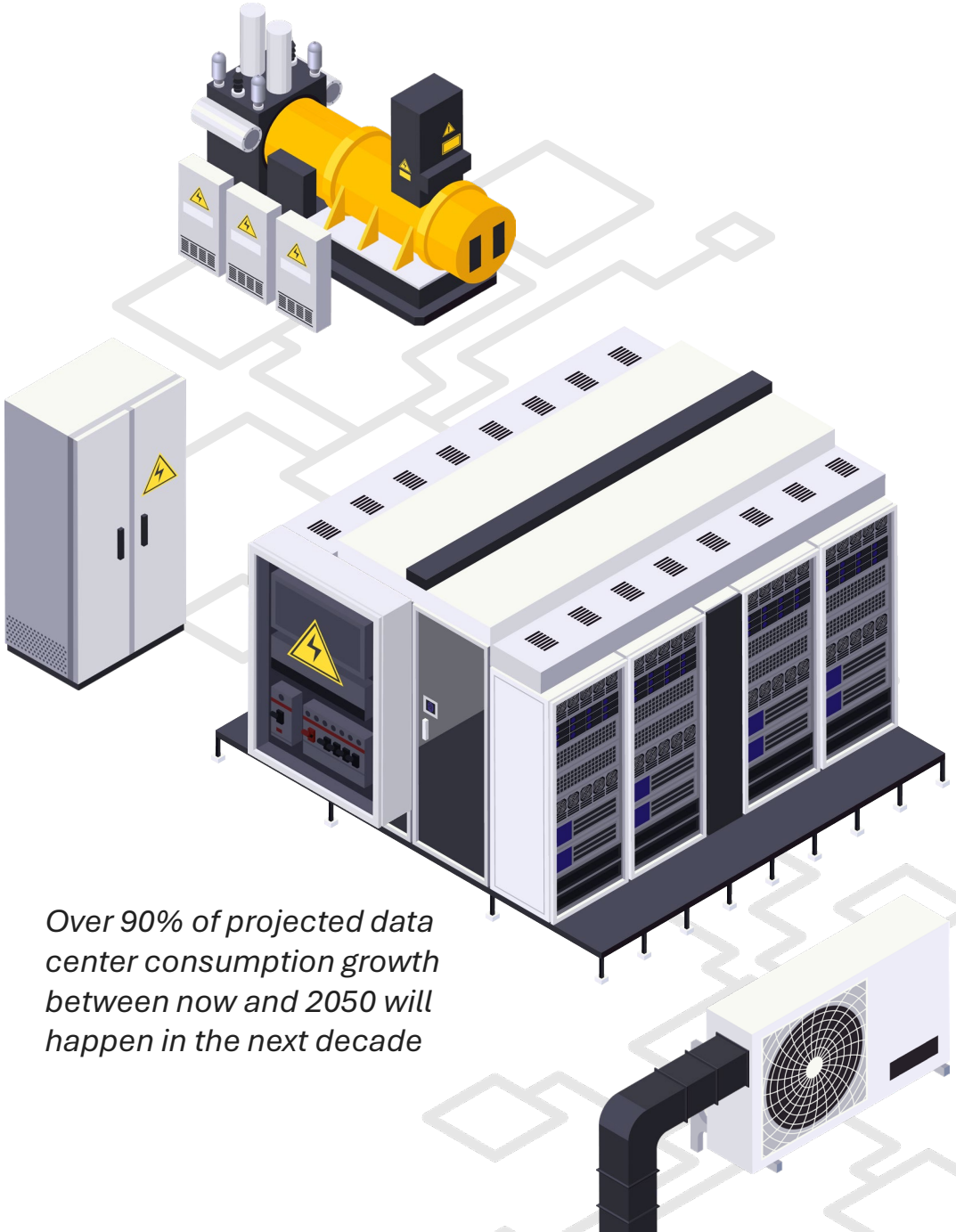
Monitoring the temperature of power lines allows grid operators to ***maximize power flows*** based on real-time weather conditions.

Digital Substations

Adding sensors and communication networks to monitor and control distribution systems increases capacity***, improves reliability***, and enhances safety.

Advanced Metering

Upgrading to smart meters that analyze electricity delivery and consumption improves efficiency, speeds ***outage response***, and facilitates ***demand response*** during peak periods.



Over 90% of projected data center consumption growth between now and 2050 will happen in the next decade

Technology Solutions

Optimize Data Center Performance

Energy-Saving Technologies

Fully deploying energy-saving technologies ***cost effectively*** meets data center energy needs: HVAC controls, motor-drive systems, air flow management, efficient uninterruptible power supplies (UPS), LEDs & advanced lighting controls, efficient transformers, and DC power distribution.

Data Center Pre-Cooling & Liquid Cooling

Scheduling cooling for off-peak times and using more efficient options like liquid cooling ***decreases peak demand***, reducing costs and boosting overall grid reliability.

Storage, Microgrids, and On-Site Generation

Installing backup power systems like energy storage, microgrids, and behind-the-meter generation ***reduces grid strain*** and improves reliability—even during the most severe grid outages.

Technology Solutions

Bridge to a Resilient System via Storage

Over the next 15 years, the amount of storage connected into the U.S. electricity grid will grow by 1100%

Grid-Scale Energy Storage

Large-scale energy storage systems stabilize the grid, store excess renewable energy, and provide critical backup power, ***ensuring reliability and flexibility*** for fluctuating electricity demand.

Behind-the-Meter Energy Storage

Customer-sited storage solutions optimize energy use, ***reduce grid strain*** during peak demand, and enhance resilience by providing localized backup power and demand-side flexibility.

Long-Duration Energy Storage

Extended-duration storage technologies supply power over hours or days, ***mitigating intermittency*** and strengthening grid reliability during prolonged low-generation periods.

Technology Solutions

Design EV Systems to Optimize Grid Impact

Vehicle-to-Grid Integration

EVs can discharge power back to the grid during peak demand, ***providing grid stability*** and ***demand response services***.

Managed Charging

Smart charging strategies adjust EV charging times to off-peak periods, reducing strain on the grid and ***enhancing load balancing***.

Distributed Energy Storage

EV batteries serve as decentralized energy storage, helping absorb excess renewable energy and ***mitigate fluctuations*** in supply and demand.

Grid Resilience & Backup Power

EVs can act as ***mobile power sources***, supporting homes, businesses, and emergency services during outages.

A 10-fold increase in EVs on the road is projected by 2030 – resulting in the second largest area of electrification growth in the U.S. economy

Policy Solutions

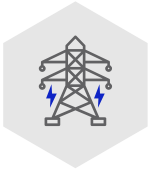
Policy Instruments To Support America's Energy System

Achieve Permitting and Transmission Reform

- Streamline permitting and siting for generation, transmission, distribution, and critical minerals
- Improve interregional electric transmission
- Encourage adaption of Grid Enhancing Technologies (GETs)

Secure Tax Certainty

- Harness energy tax incentives to invest in essential grid technologies and grow domestic manufacturing of critical grid infrastructure
- Deploy tax credits and incentives that enable utilities to make significant smart grid, distributed energy, and resiliency investments



Advance All-of-the-Above Energy Policies

- Encourage diverse generation from natural gas, small modular reactors, and geothermal as a bridge to reliable, clean power

Encourage Consistent Trade Policies

- Encourage transparent and consistent tariff policies
- Leverage USMCA and other existing free trade agreements to increase global competitiveness
- Limit application of waivers and exclusions for critical grid infrastructure

Grow a Skilled Energy Workforce

- Develop and expand robust apprenticeship programs for utilities and manufacturing (**LEAP Act**)
- Leverage state and federal job skills, technical training, and certification programs
- Advance workforce development legislation to train the next generation of electrical industry

Create Supply Chain Certainty

- Expand 45X production tax credit to include distribution transformers (**CIRCUIT Act**)
- Secure a favorable tax and trade environment to encourage domestic electrical steel production
- Secure favorable domestic content requirements

NEMA
Make it Electric
www.makeitelectric.org