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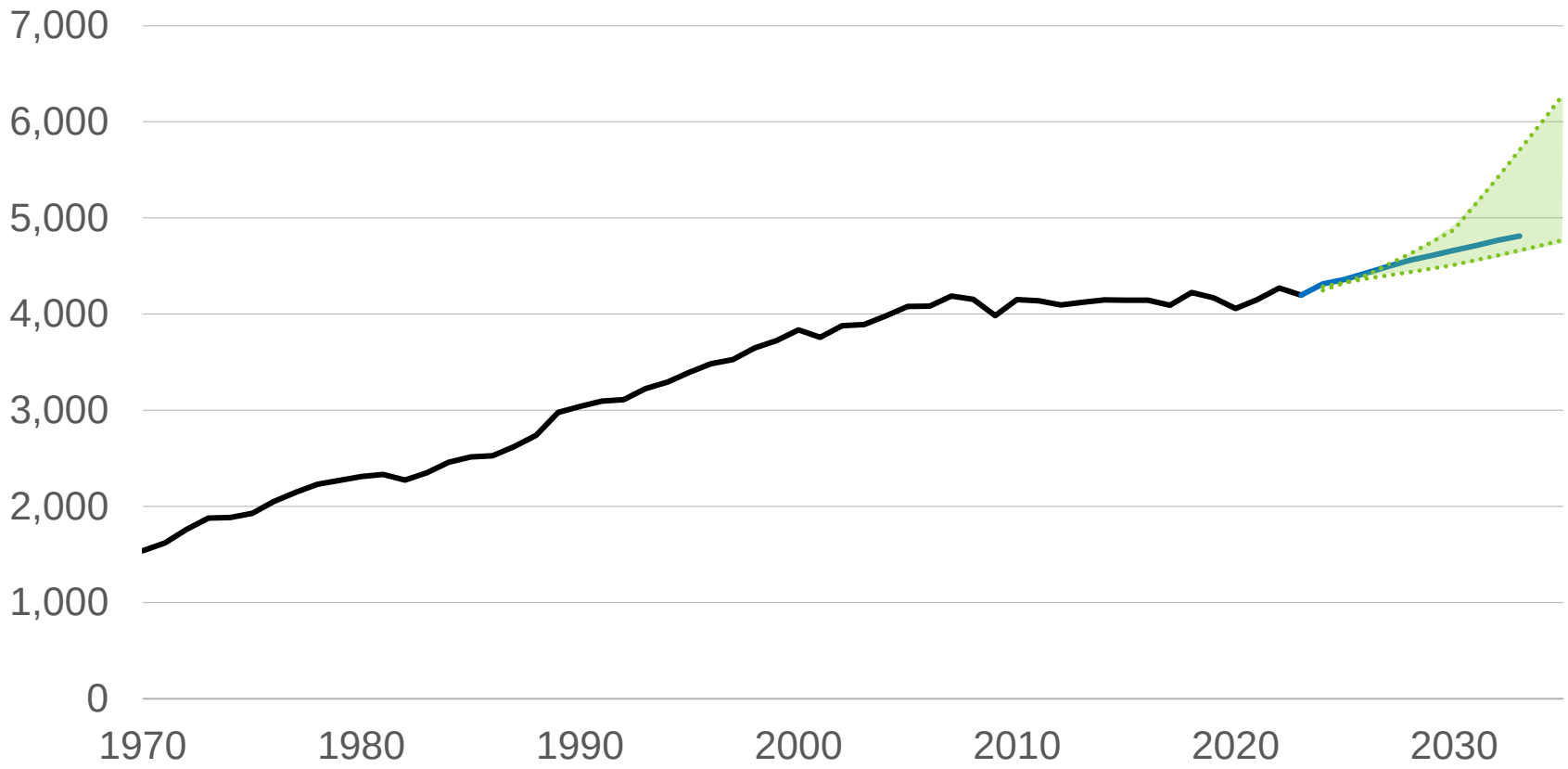
Pathways to Commercial Liftoff Topic Brief:

Clean Energy as a Solution to Rising Electricity Demand

September 2024

Electricity Demand (TWh)



Actual Annual Electricity Demand

Demand Forecasts

NERC (Dec 2023)

Net Zero Aligned

NREL (100% Clean by 2035, Low & High Demand Growth, Jan 2024)

Data source: NERC *Electricity Supply and Demand Data* (2023); EIA, *Monthly Energy Review*; NREL *Pathways to 100% Clean Electricity* (2022).
Note that electricity demand here includes transmission losses and direct use.

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The available portfolio of solutions to meet electricity demand

Grid Scale Clean Energy Deployment

Grid Infrastructure Enhancement and Expansion

Energy Efficiency and Demand Side Flexibility

Expand existing supply
(including repurposing existing infrastructure)

- *Solar*
- *Onshore wind*
- *Storage (batteries)*
- *Hydropower*
- *Conventional geothermal (hydrothermal)*
- ***► Nuclear****
- ***► Offshore wind***
- *….*

Enhance existing T&D with advanced grid solutions***

- ***► Advanced reconductoring***
- ***► Grid-enhancing technologies***
- ***► Point-to-point HVDC***
- ***► Distribution automation***
- ***► Advanced flexible transformers***
- *….*

Improve energy efficiency

- *Building efficiency*
- ***► Geothermal heating and cooling***
- *…*

Scale emerging solutions

- ***► Advanced nuclear****
- ***► Next-gen geothermal***
- ***► Long Duration Energy Storage (LDES)***
- ***► CCS on power plants*****
- ***► Clean hydrogen***
- *Concentrated Solar Power*
- *….*

Build new T&D

- *Advanced conductors*
- *Interregional and regional high voltage DC / AC transmission*
- *Distribution system*
- *…*

Manage and flex demand

- ***► Virtual power plants***
- *Distributed energy resources*
- *Microgrids*
- *Fuel cells*
- *…*

NOT EXHAUSTIVE

► Covered by a Liftoff report (as of July 2024)

► Forthcoming Liftoff report (as of July 2024)

Not covered by a Liftoff report (as of July 2024)

**Covered by the "Advanced Nuclear" Liftoff report **Covered by the "Carbon Management" Liftoff report ***Covered by the "Innovative Grid Deployment" Liftoff report*

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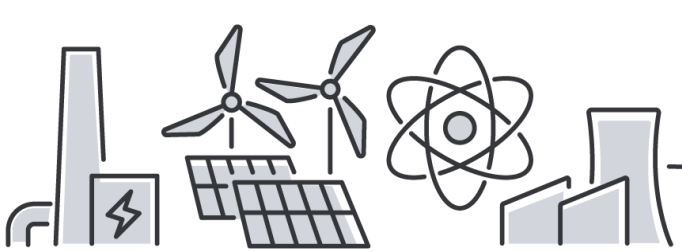
Three priority opportunities for liftoff to meet rising demand

Grid Scale Clean Energy Deployment



Invest now in clean bulk power generation and storage

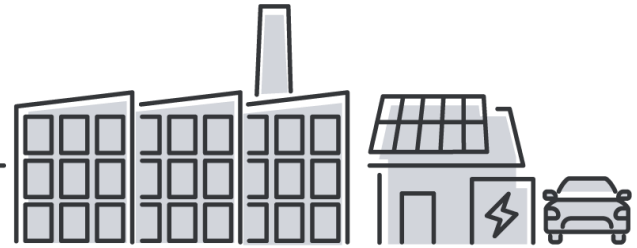
to add baseload supply that complements variable renewables and replaces aging power plants

Grid Infrastructure Enhancement and Expansion

Enhance the existing grid now with advanced grid solutions

to increase utilization of the existing system

Energy Efficiency and Demand Side Flexibility



More efficiently serve demand now with Virtual Power Plants

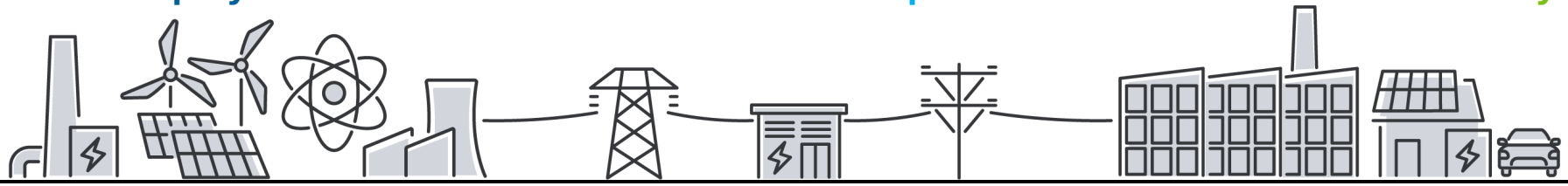
that aggregate distributed resources to serve, shift, and reduce overall demand

Opportunity at stake by the mid-2030s

Grid Scale Clean Energy Deployment

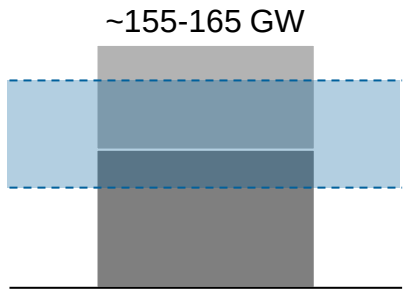
Grid Infrastructure Enhancement and Expansion

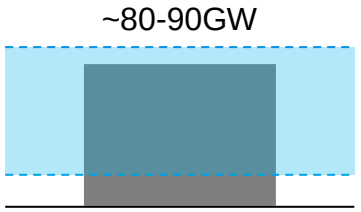
Energy Efficiency and Demand Side Flexibility

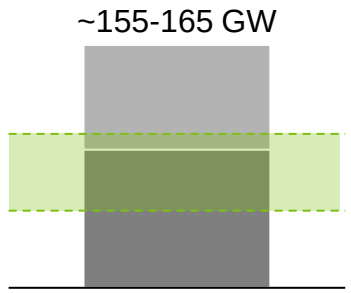


Mid-2030s Liftoff deployment potential vs. peak electricity demand resource needs
(GW)

- Peak demand growth
- Peak demand served by retiring assets
- Range of Liftoff potential supply capacity







Mid-2030s Liftoff deployment potential
(GW)

~65-135 GW

Adv. Nuclear
Offshore Wind
Next-Gen Geo.

CCS
LDES
Hydrogen*

>20-100 GW

Advanced Grid Solutions
(*Innovative Grid Deployment*)

>50-100 GW

Virtual Power Plants

Example solutions not covered by Liftoff reports that are also available to meet system needs

Utility-scale solar, onshore wind, batteries, hydropower

New T&D builds, co-location of demand with supply to reduce needs

Energy efficiency, micro-grids

Notes: LDES = Long Duration Energy Storage, CCS = Carbon Capture Storage; *Clean hydrogen as a generation or storage solution is not included in the capacity potential; continued advances in cost reduction and technical performance are necessary to enhance the commercial viability of clean hydrogen as a power solution
Sources: DOE Liftoff Reports, NERC Long Term Reliability Assessment (2023). See the full Topic Brief for additional detail.

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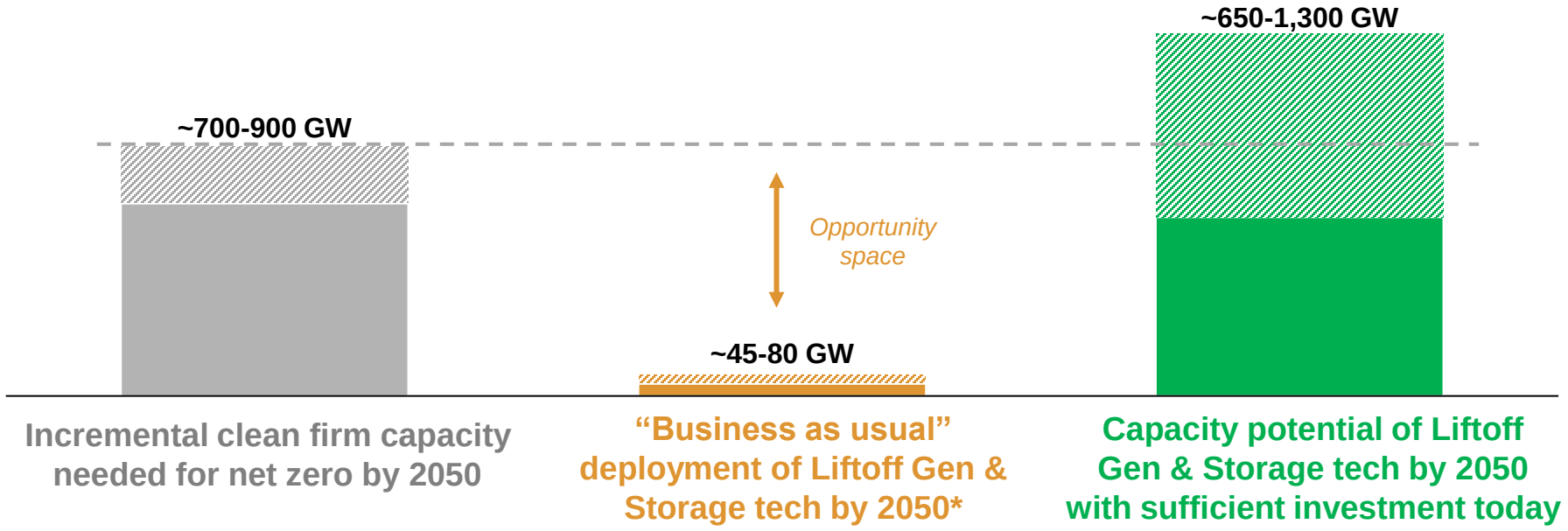
Investment today can help these sectors stay on track for the clean firm generation needed by 2050

2050 Incremental Capacity Additions (GW)



Bulk power generation and storage technologies covered by the Liftoff reports:
Advanced Nuclear, Next-Gen Geothermal, Offshore Wind, CCS on power plants, Clean Hydrogen, Long Duration Energy Storage

*Does not include LDES capacity additions as LDES is not included in NREL's Standard Futures outlook.
Sources: DOE Liftoff Reports, NERC Long Term Reliability Assessment (2023). See the full Topic Brief for additional detail.

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Key actions to advance deployment of solutions covered by the Liftoff reports

Only includes energy and grid solutions covered by the Liftoff reports; does not include all solutions available to serve demand

Priority Opportunities	Grid Scale Clean Energy Deployment: Invest *now* in clean bulk power generation and storage	Grid Infrastructure Enhancement and Expansion: Enhance the existing grid *now* with rapid deployment of advanced grid solutions	Energy Efficiency and Demand Side Flexibility: Better manage demand *now* with rapid deployment of VPPs
Key Actions *& stakeholders*	**Establish forward-looking committed orderbooks** ▶ *Grid operators* ▶ *Off-takers* ▶ *Tech. providers & developers*	**Evaluate as options to address near-term demand needs** ▶ *Grid operators* ▶ *Off-takers* ▶ *Regulators & policymakers* ▶ *Technology providers & developers*	
	Standardize and simplify project development processes ▶ *Grid operators* ▶ *Technology providers & developers* ▶ *Industry ecosystem (trade associations, consultants etc.)* ▶ *Community & labor groups*		
	Revamp grid planning and market reforms ▶ *Grid operators* ▶ *Regulators & policymakers* ▶ *Off-takers*		
	Engage local communities and labor groups to de-risk deployments ▶ *Grid operators* ▶ *Regulators & policymakers* ▶ *Technology providers & developers* ▶ *Industry ecosystem (trade associations, consultants etc.)* ▶ *Community & labor groups*		

KEY STAKEHOLDERS IDENTIFIED ARE NOT EXHAUSTIVE

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Momentum is building… and needs to continue

Grid Scale Clean Energy Deployment

Grid Infrastructure Enhancement and Expansion

Energy Efficiency and Demand Side Flexibility

Expand existing supply & Scale Emerging Solutions

Google, NV Energy, Fervo (NV)
- Partnership to develop next-gen geothermal, paid through a Clean Transition Tariff financing approach

Duke, Amazon, Google, Microsoft, Nucor (NC)
- MOU to explore innovative financing structures to support deployment of new carbon-free energy generation (such as advanced nuclear)

Meta, Sage Geothermal (Eastern US)
- Partnering to develop first-of-a-kind next-gen geothermal east of Rockies for data centers

Iron Mountain (PA & WV)
- 24/7 PPA to add up to 150 MW of hydro power to existing non-powered dams to power data center

Tennessee Valley Authority (TN)
- Additional $150m to develop small modular reactors (SMRs) to support local load growth

Enhance existing T&D with advanced grid solutions

EPRI (US)
- Launched GET SET initiative to address utility implementation barriers

Dominion Energy (VA)
- Using GETs (as a DOE GRIP selectee) to enhance transmission capacity

VA Dept of Energy (VA)
- Deploying GETs and other T&D solutions (as a DOE GRIP selectee)

FERC (US)
- Order 1920 requires consideration of advanced transmission technologies

Manage and flex demand

Xcel Energy (MN)
- Proposed a VPP with 440 MW of solar and 400 MW of battery storage as part of its long-term integrated resource plan (IRP)

Colorado
- Passed legislation requiring Xcel Energy to create a VPP by 2025

Maryland
- Passed the DRIVE Act requiring utilities to submit vehicle-to-grid charging plans and VPP plans to regulators in 2025

IEEE (US)
- Developing a standard for VPPs (IEEE P2030.14)

NARUC & NASEO (US)
- DER Integration and Compensation curriculum expanded with *Aggregated DERs in 2024: The Fundamentals*

EXAMPLES ARE NOT EXHAUSTIVE

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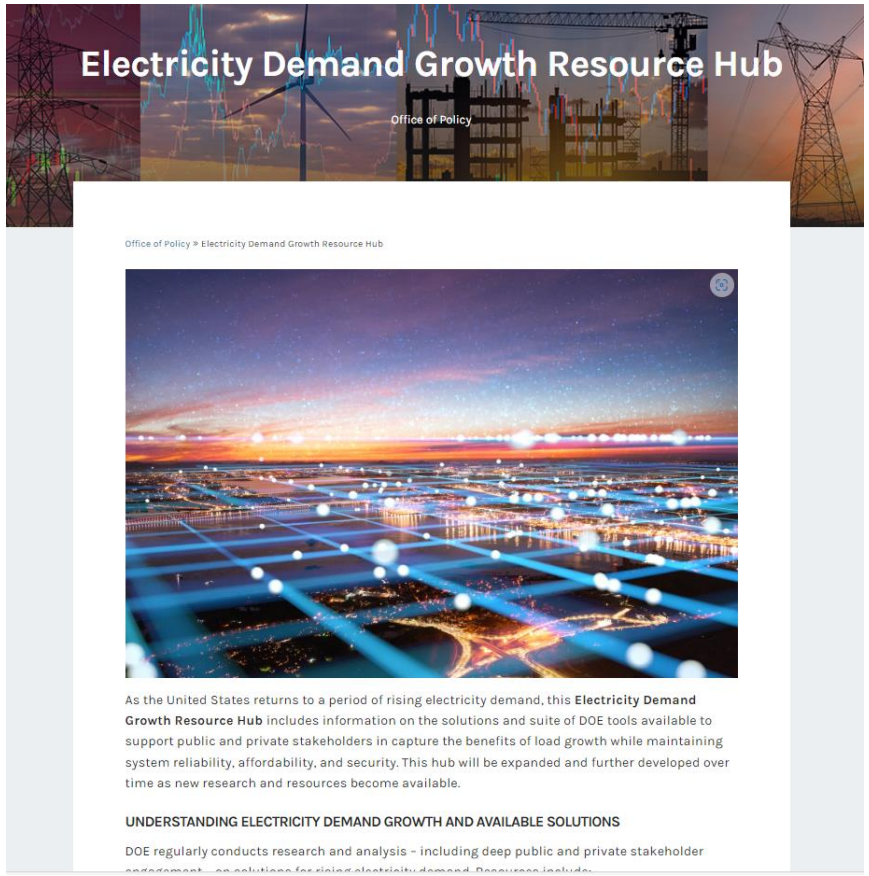
New DOE resource Electricity Demand Growth Resource Hub



Access the **Electricity Demand Growth Resource Hub** at energy.gov/electricitydemand

Resources include:

- Summary of 30+ DOE resources available (e.g., technical assistance, grants, loans, data center efficiency programs)
- DOE and National Lab research reports
- Secretary of Energy Advisory Board's strategic recommendations to DOE
- Upcoming relevant events

For questions/comments related to electricity demand growth, contact us at businesshub@hq.doe.gov

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Thank you!

This and all other Liftoff reports and webinars can be found at **liftoff.energy.gov**

Feedback is welcome at **liftoff@hq.doe.gov**