The Office of Electricity Grid Modernization R&D Portfolio

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Office of Electricity

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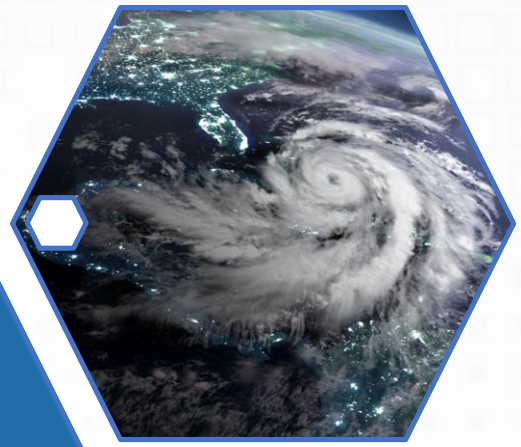
United States Department of Energy - Office of Electricity

- The Office of Electricity (OE) provides national leadership to ensure that the Nation's ***energy delivery system*** is secure, resilient and reliable.

- OE works to develop new technologies to improve the infrastructure that brings electricity into our homes, offices, and factories, and the federal and state electricity policies and programs that shape electricity system planning and market operations.

Administration Priorities



Combating the Climate Crisis

Promoting Energy Justice

Creating Clean Energy Union Jobs

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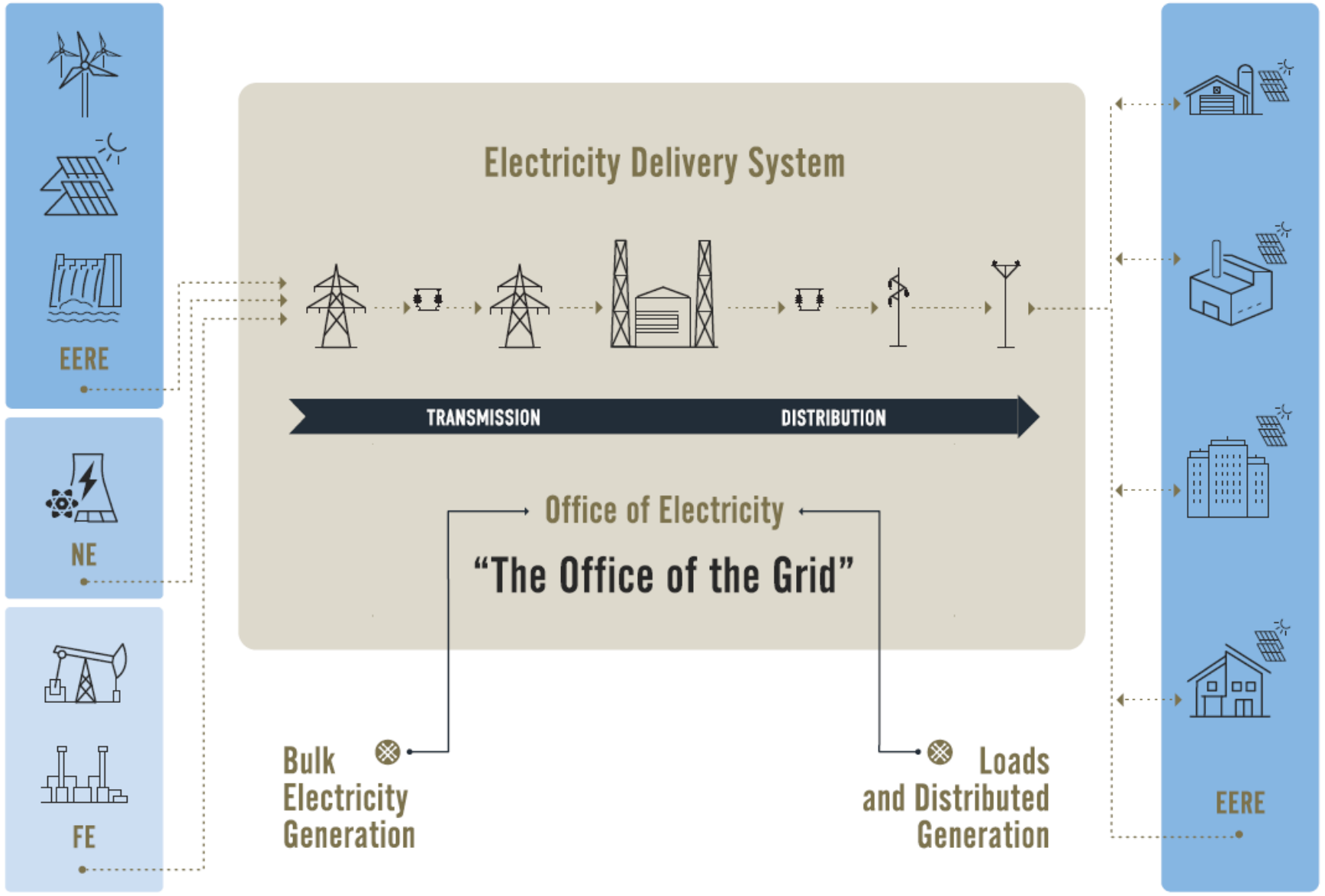
The Office of the Grid



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Elements to Meeting the 2035 Goal of a Carbon-Free Grid

Operating a Decarbonized Grid

- Accommodating the Increase in Variable Generation
- Operating an Inverter-Based Grid
- Supporting the Electrification and Decarbonization of Transportation, Industrial, and Other Loads
- Addressing Bidirectional Flows from Distributed Energy Resources and the Seams Between Transmission and Distribution Systems

Addressing Infrastructure Needs and Interdependencies

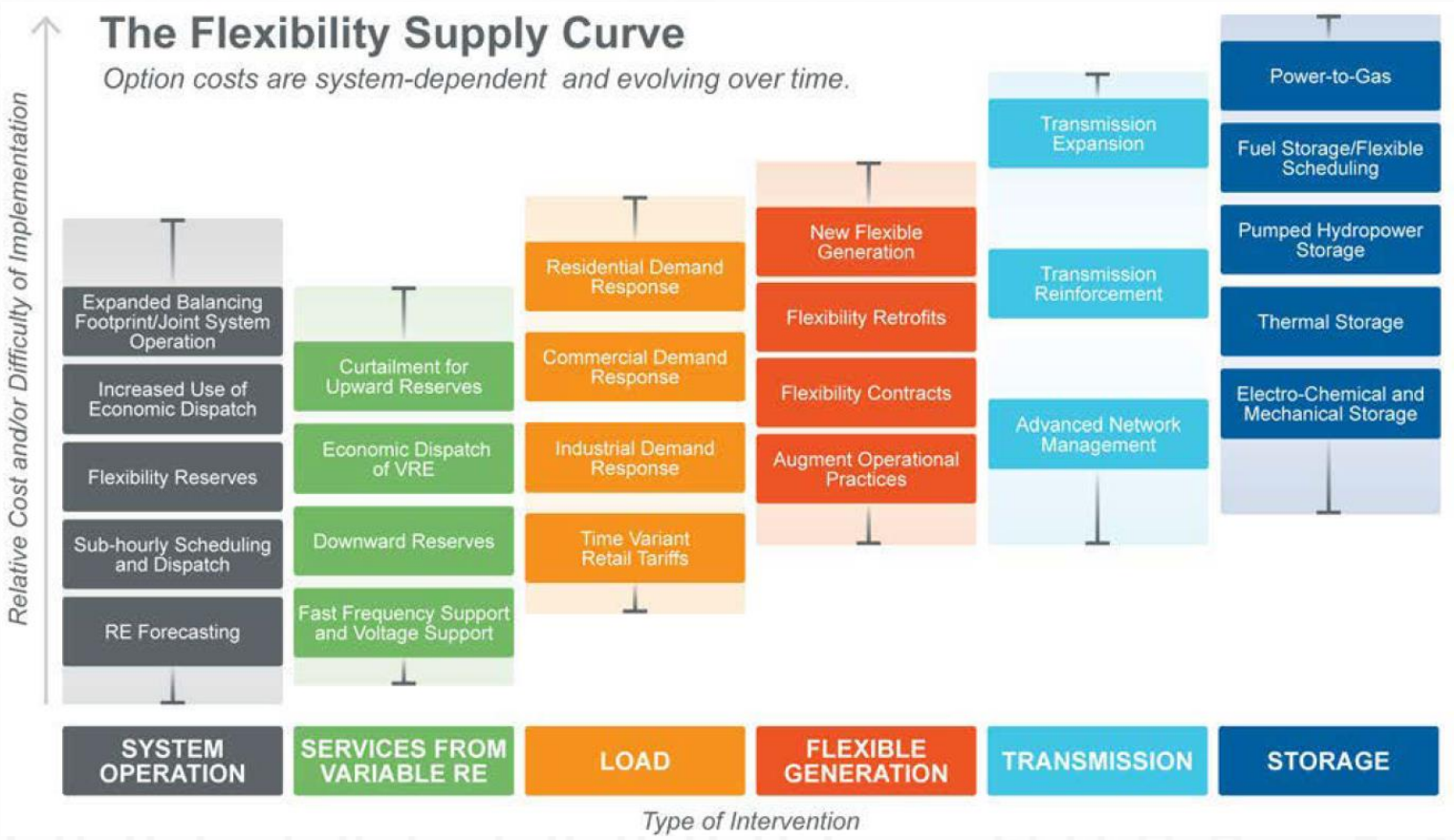
- Addressing Interdependencies Between Electricity, Fuels, and Other infrastructures
- Deploying Additional Transmission Capacity and Increasing Existing Transmission Capacity Utilization
- Deploying Distribution Infrastructure Capacity to support Distributed Energy Resources at the Grid Edge

Accommodating Diverse Markets, Policies, and Business Models

- Addressing the Lack of Sophisticated Analytical Capabilities for Policymakers to Make Data-Driven Decisions
- Developing New Business Modes for an Evolving Grid
- Developing New Market and Policy approaches for an Evolving Grid

Accommodating Increased Variable Generation

- Increased use of variable generation will require new planning methods and increased system flexibility
- New planning methods for assessing resource adequacy, resilience, and account for flexible system operations
- Methods to Improve System Flexibility include:
  - Improving System Operations and Forecasting
  - Increased use of Grid Services from Variable RE
  - Load and Demand Response
  - Flexible Operations
  - Transmission
  - Storage (seconds to seasonal)



Chernyakhovskiy, I. et al. 2021. *USAID Energy Storage Decision Guide for Policymakers*. NREL/TP-6A20-78815.

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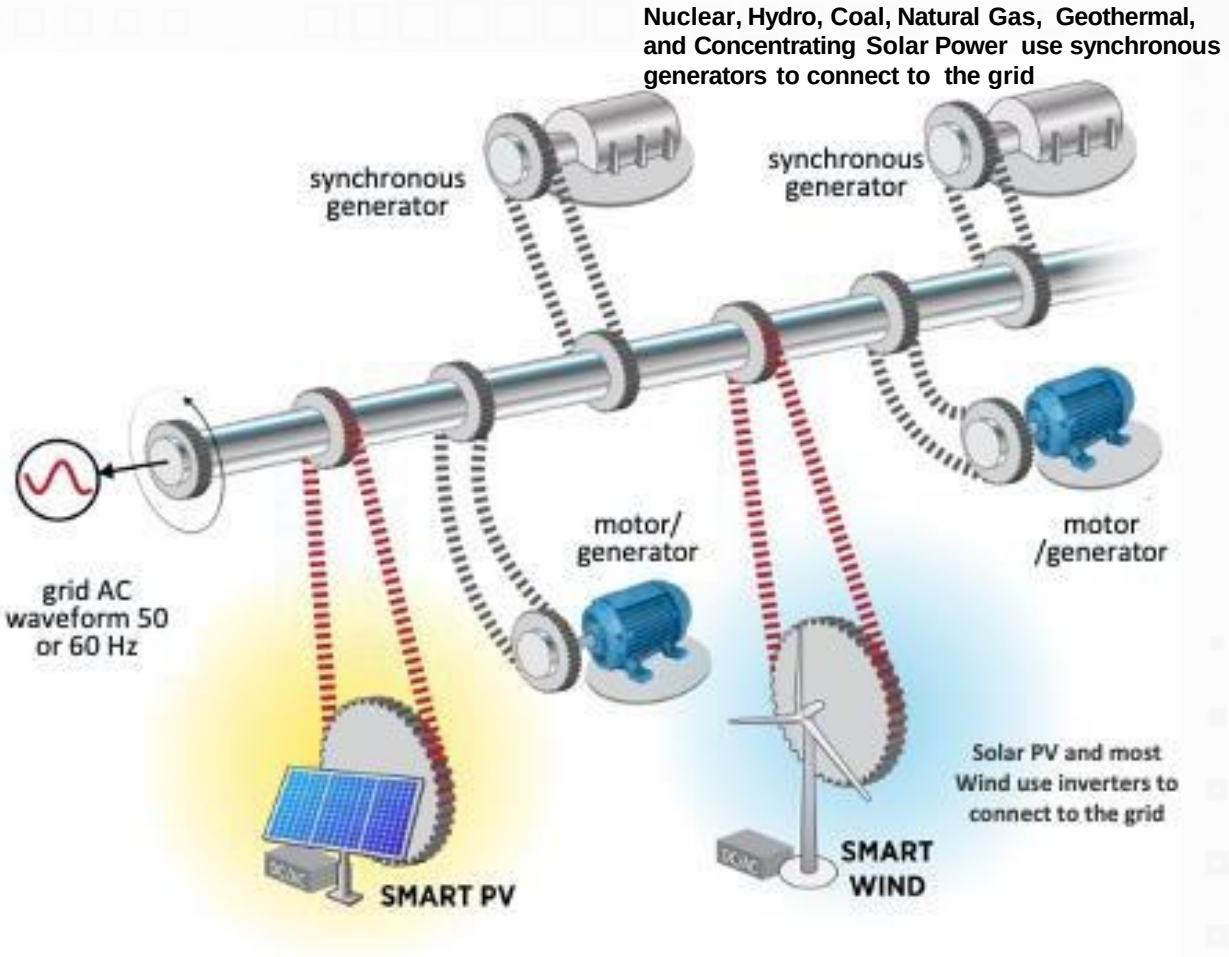
Operating an Inverter-Based Grid

- The changing fleet of generation technology fundamentally changes the operational characteristics and limits of the power system
- The power system must remain operable as the transition from synchronous machine dominant to IBR dominant power systems occurs
- **Challenges**
  - Frequency Support (inertia)
  - Voltage Support (var support)
  - Grid-forming Capability (small-signal stability)
  - Black Start
  - Protection issues with Lower Fault Current
  - Control System Interactions and Resonances



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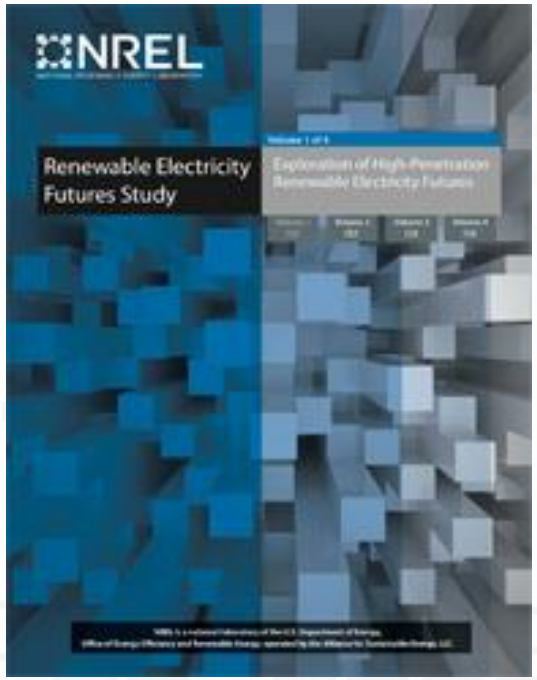
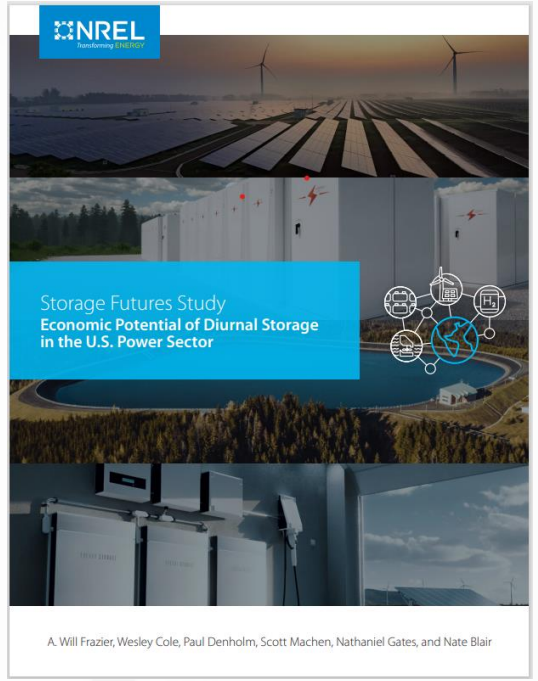
Achieving Grid Decarbonization by 2035

Grid storage is now the critical technology constraint to electricity decarbonization.

- **The decarbonized grid requires much more storage capability.**
- A highly decarbonized grid could require **1200-2300 GWh** of storage (from <300 GWh today)
- **Long duration (10+ hours)** storage will be increasingly important (<4 hrs systems typical today)





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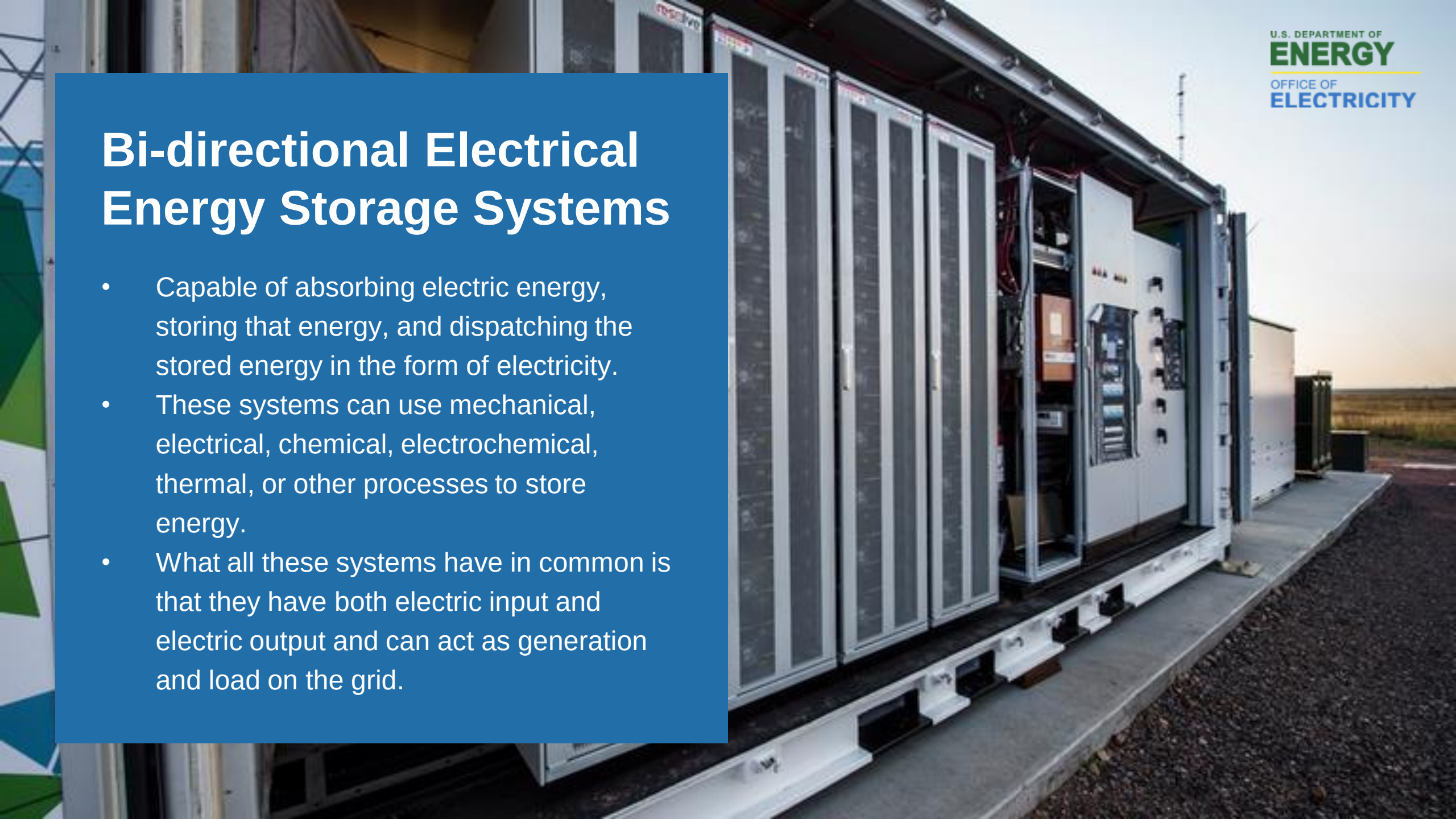

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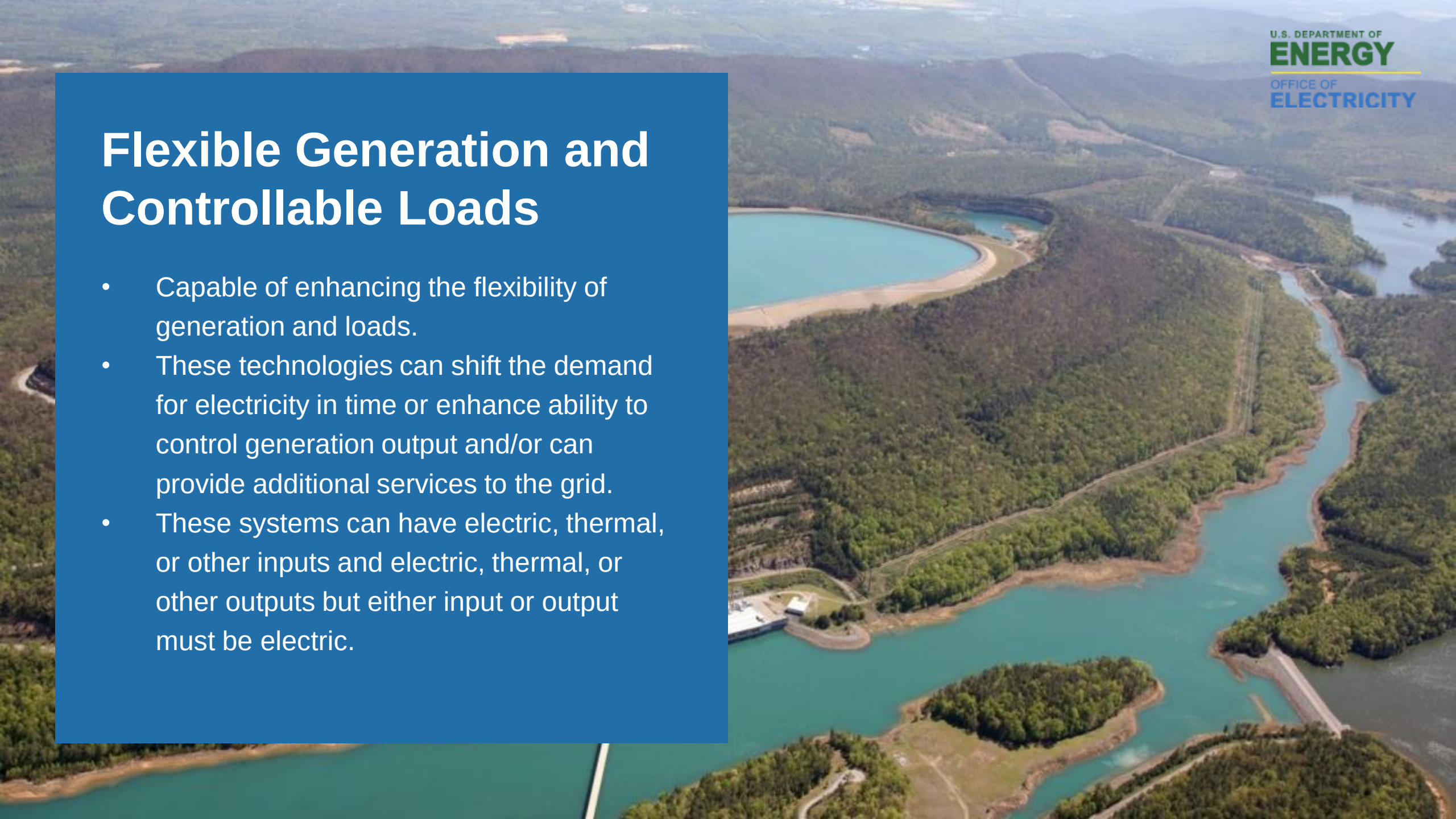
Bi-directional Electrical Energy Storage Systems

- Capable of absorbing electric energy, storing that energy, and dispatching the stored energy in the form of electricity.
- These systems can use mechanical, electrical, chemical, electrochemical, thermal, or other processes to store energy.
- What all these systems have in common is that they have both electric input and electric output and can act as generation and load on the grid.



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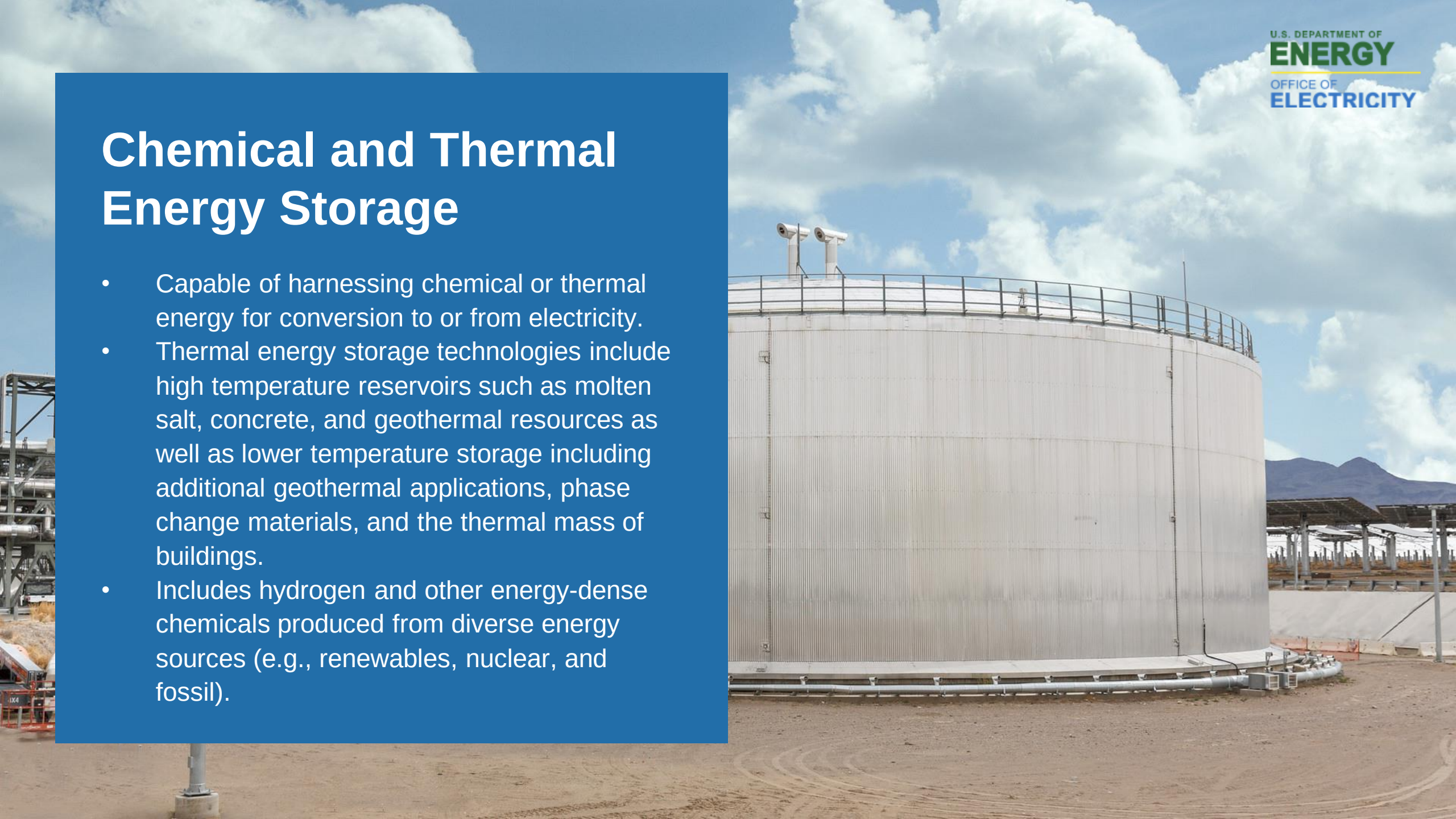
Flexible Generation and Controllable Loads

- Capable of enhancing the flexibility of generation and loads.
- These technologies can shift the demand for electricity in time or enhance ability to control generation output and/or can provide additional services to the grid.
- These systems can have electric, thermal, or other inputs and electric, thermal, or other outputs but either input or output must be electric.

Chemical and Thermal Energy Storage

- Capable of harnessing chemical or thermal energy for conversion to or from electricity.
- Thermal energy storage technologies include high temperature reservoirs such as molten salt, concrete, and geothermal resources as well as lower temperature storage including additional geothermal applications, phase change materials, and the thermal mass of buildings.
- Includes hydrogen and other energy-dense chemicals produced from diverse energy sources (e.g., renewables, nuclear, and fossil).



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Energy Storage Grand Challenge (ESGC)

ENERGY STORAGE
GRAND CHALLENGE
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ESGC Mission

The ESGC will focus resources from across the DOE to create a comprehensive program to accelerate the development and commercialization of next-generation energy storage technologies and sustain U.S. global leadership in energy storage

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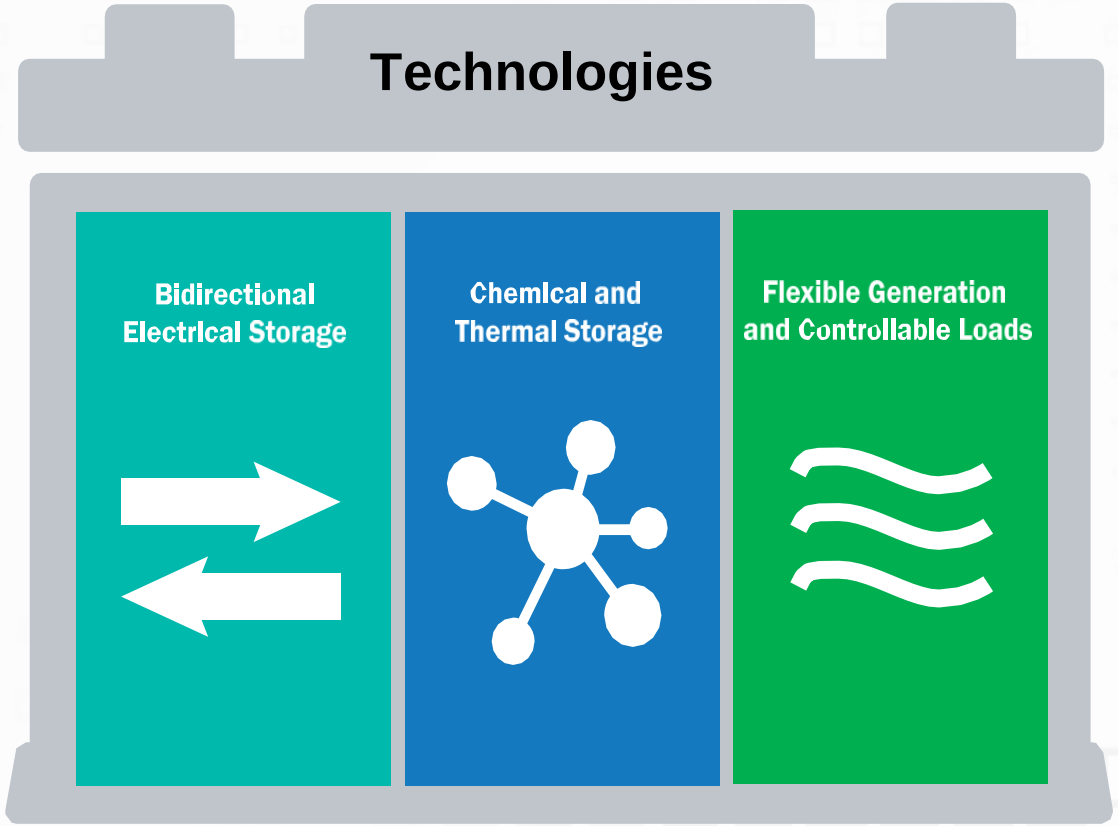
DOE-wide strategy to accelerate U.S. leadership in energy storage

Technologies



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Offices

- Office of Electricity
- Energy Efficiency and Renewable Energy
- Nuclear Energy
- Fossil Energy
- Office of Science
- Office of Technology Transitions
- ARPA-E
- Loan Programs Office

Functions

Basic Science Research & Discovery → Application Driven Materials Development → Applied Device and System R&D → Cost & Performance Metrics, Targets → Demonstration and Performance Validation → Systems Analysis and Valuation → Commercialization Strategy

Addressing Key Challenges

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How can DOE work to lower the cost and energy impact of manufacturing existing technologies, and strengthen domestic supply chains by reducing dependence on foreign sources of materials and components?

How can DOE enable the United States to lead in energy storage R&D and retain IP developed through DOE investment in the United States?

How can DOE work with relevant stakeholders to develop technologies that meet our domestic usage needs and enable the United States to not only successfully deploy technologies in domestic markets but also export technologies?

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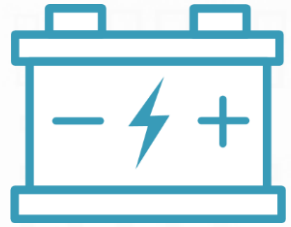
Long Duration Storage Shot

Affordable grid storage for clean power – any time, anywhere

Reduce storage costs by

90%

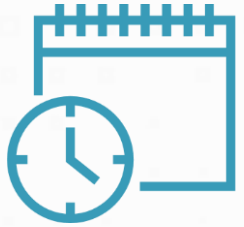
from a 2020 Li-ion baseline...



...in storage systems that deliver

10+

hours of duration



...in

1

decade

ENERGY earthshots
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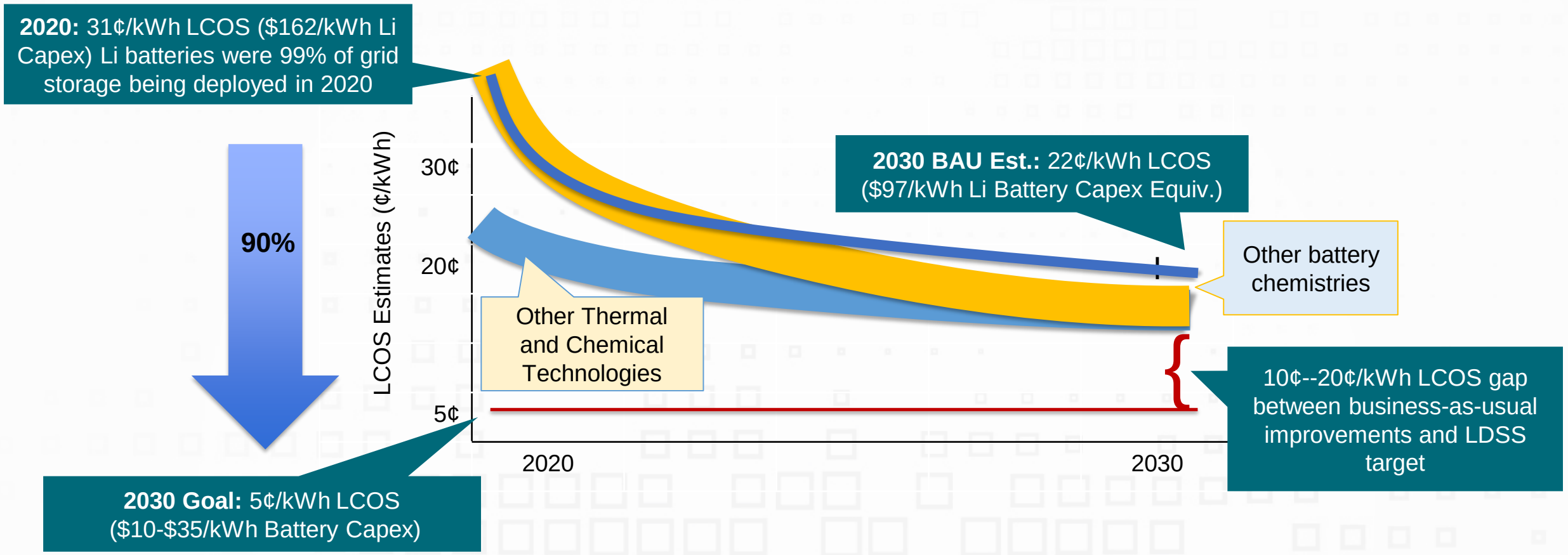
Ambition: Significant Storage Cost Decreases Required

Business-as-usual Projections of Storage Price Decreases (10-hour system)



2020 and 2030 costs based on ESGC 2020 Grid Energy Storage Technology Cost and Performance Report
https://arpa-e-foa.energy.gov/FileContent.aspx?FileID=f7c227e5-d875-4694-a31f-ce5d2b8d1053

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Join us for the Storage Shot Summit

September 23 | 11:00 AM – 5:00 PM EDT

More details to follow.

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Thank You