U.S. DEPARTMENT OF ENERGY
Office of Electricity

DOE Storage Update

Electricity Advisory Committee

Fall 2021

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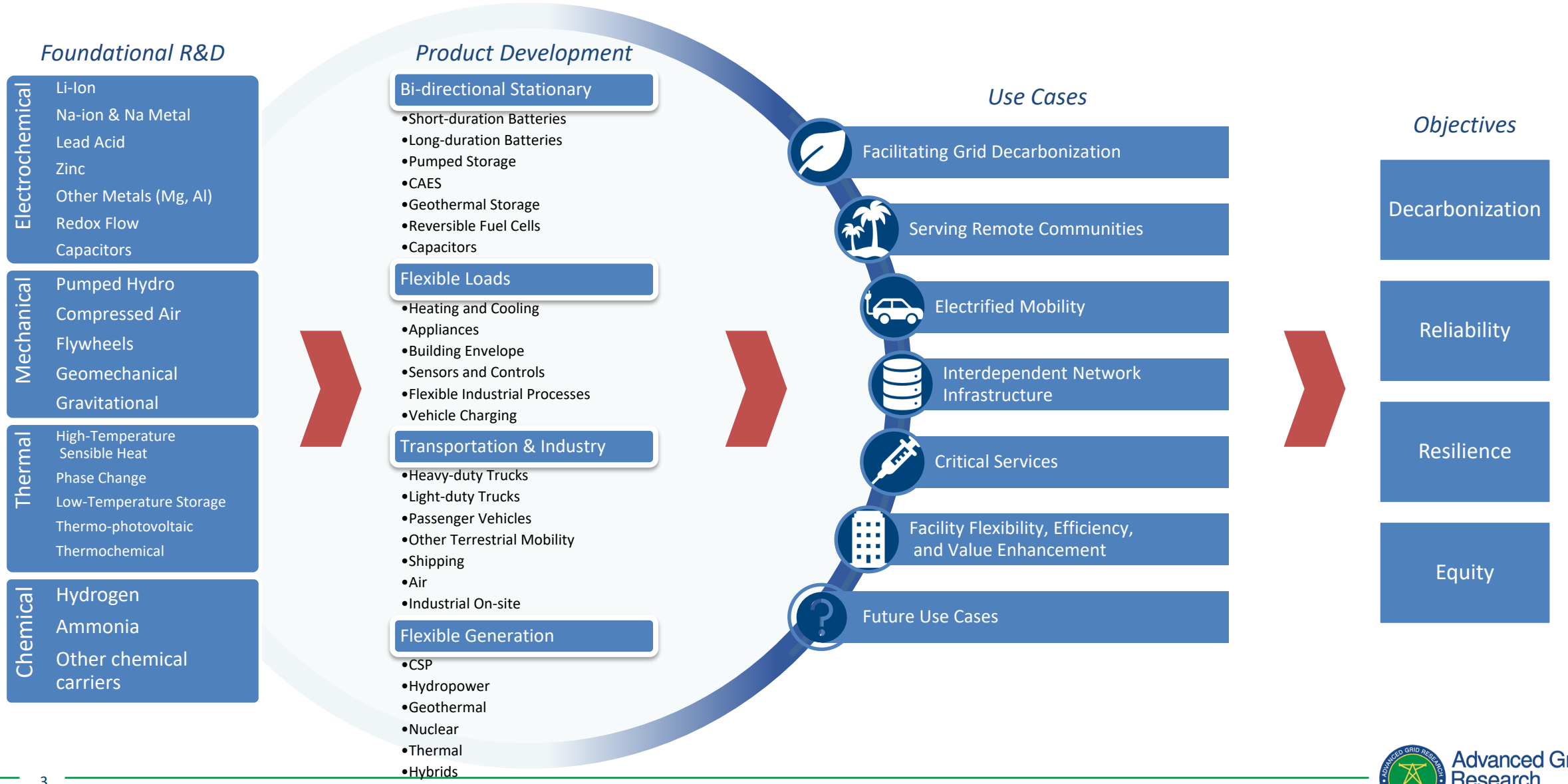
October 20, 2021

Fall 2021 Storage Update

- Energy Storage Grand Challenge (ESGC) Review
- Evolution of ESGC into the Long Duration Storage Earthshot
- September 2021 Storage Summit
- DOE Storage Investment Overview and Open Opportunities
- DOE-Storage Industry Highlights
- Upcoming Events

Energy Storage Grand Challenge: Use Case Framework



Storage Requirements by ESGC Use Cases

Use Cases highlighted in the Long Duration Storage Earthshot

Facilitating an Evolving Grid

Success Statement	Potential Cost Targets
•Cost-effective storage, flexibility, and enabling technology solutions to maintain and enhance the provision of electricity services to end users as the grid increases in complexity and diversity Other key important parameters are: safety, availability, and modularity.	•$9–$177/kw-yr •$20–$150/kwh Capex •$0.05/kwh-cycle

Electrified Mobility

Success Statement	Potential Cost Targets
•Clean and cost-effective storage solutions that facilitate a large-scale adoption of electric vehicles while maximizing beneficial coordination with the power grid	•$$12–$269/kw-yr Capex •$100/kwh Cell/Pack Cost

Critical Services

Success Statement	Potential Cost Targets
•Cost-effective storage solutions that maintain critical services for a sufficient duration following extended power outages.	•$2–$283/kw-yr •$1205–$1546/kw-yr

Serving Remote Communities

Success Statement	Potential Cost Targets
•Clean, resilient, and cost-effective storage and flexibility solutions to provide electricity for critical and beneficial public services	•$50–$80+/mwh LCOE

Interdependent Network Infrastructure

Success Statement	Potential Cost Targets
•Cost-effective storage solutions that sustain and enhance normal operations amidst short-term disruptions of energy inputs.	•$2-$283/kw-yr

Facility Flexibility, Efficiency, and Value Enhancement

Success Statement	Potential Cost Targets
• Storage and flexibility solutions that deliver net benefits including energy expenditures, comfort, and functionality •Storage and flexibility solutions that maximize the total value obtained from the process of interest	•$2–$266/kw-yr Storage Capex

ENERGY earthshots U.S. DEPARTMENT OF ENERGY | Storage™

LONG DURATION STORAGE SHOT TARGET

Reduce storage costs by **90%** from a 2020 Li-ion baseline...

...in storage systems that deliver **10+** hours of duration

...in **1** decade

Video Link: https://www.energy.gov/sites/default/files/2021-10/LD%20Storage%20Shot%20Animation.mp4

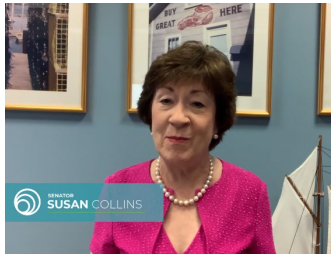
Affordable grid storage for clean power – any time, anywhere

Storage Shot Summit (Sept 23): Keynotes and Plenary

David Turk
Deputy Secretary

Ali A. Zaidi
Deputy White House
National Climate Advisor

**EAC Member*



Senator Susan Collins

Senator Angus King

Congressman
Bill Foster

Audrey Zibelman
Google X

Pat Hoffman
Acting Asst. Secretary
Office of Electricity

Gia Mahmoud
National Grid

Clay Koplin*
Cordova Electric
Cooperative

Christopher Ayers*
North Carolina
Utilities Commission
Public

ENERGY earthshots
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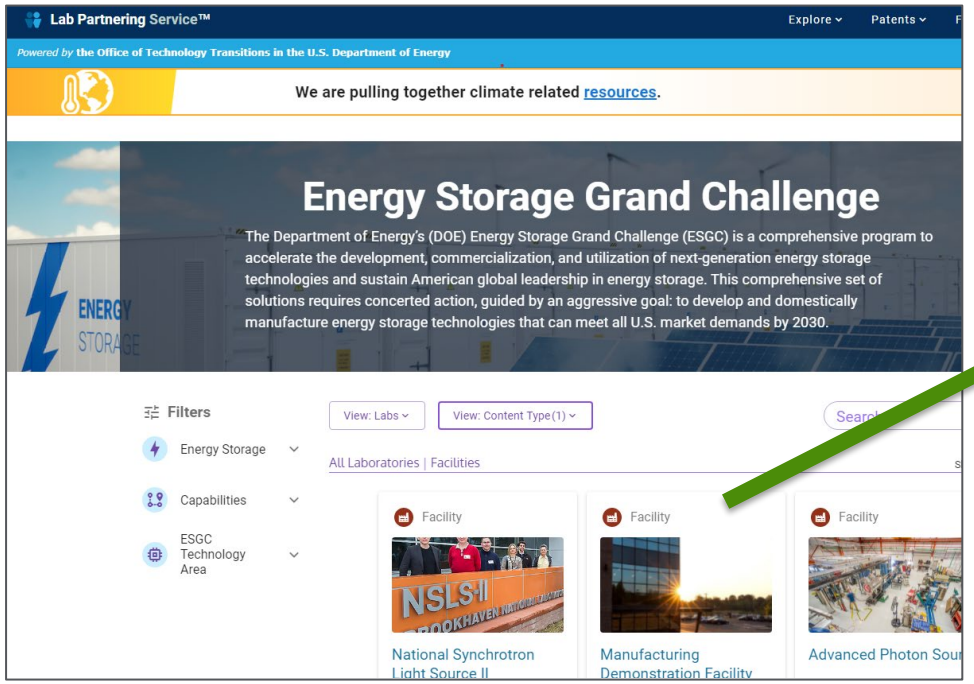
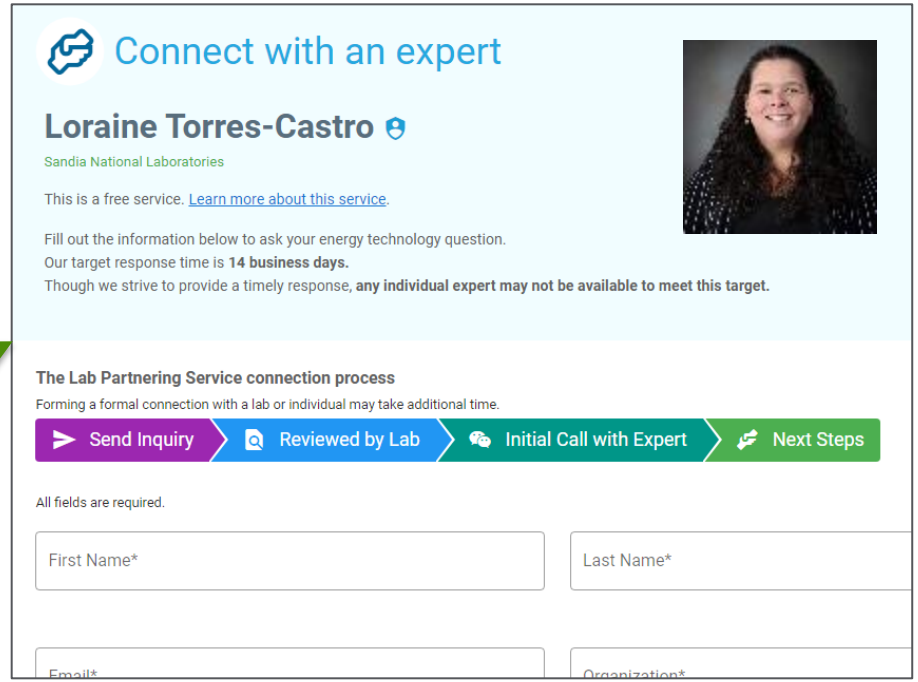
Storage Shot Summit: Launch of storage lab portal

- New portal highlights storage capabilities across the national lab complex
- Hundreds of experts, facilities, capabilities
  - Connect directly with labs to accelerate R&D and commercialization
- http://esgc.labpartnering.org





Storage Shot Summit: Rapid Operational Validation Initiative

ROVI Goal

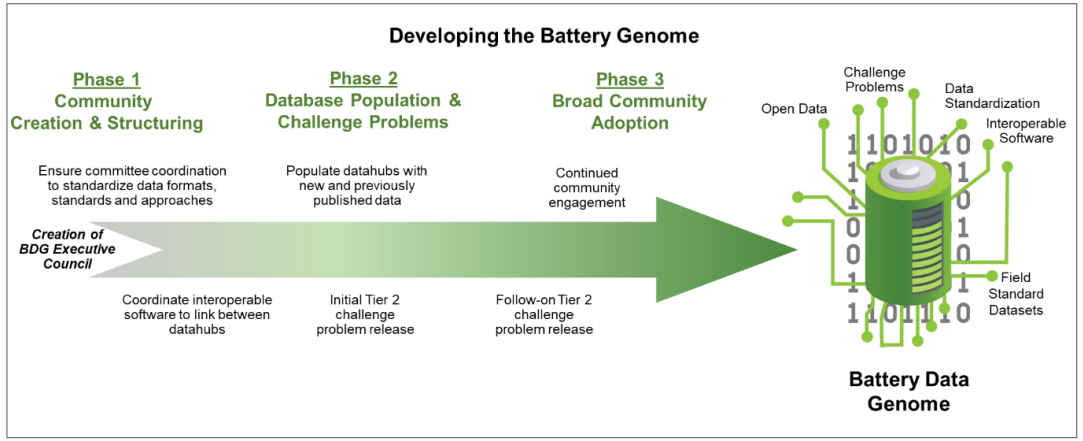
- Enable 15+ year storage financing
- With 1 year testing + AI/ML

"Principles of the Battery Genome" White Paper

- Posted on arXiv 9/14/2021
- Demonstrates DOE catalyzing industry collaborations
- Shared open data enables AI/ML transformations (akin to humane genome with biotech, medicine, health)
- 15/27 authors from DOE Labs
- Other affiliations: Oxford University, Faraday Institution, Toyota Research Institute, Helmholtz Institute Munster

ROVI Industry Roundtable

- Held on 9/23/2021
- Leading to expressions of interest from storage technology vendors, deployment, and finance
- Industry not only sees benefits, also willing to share data
- Top Story on Utility Dive, 9/27/2021



UTILITY DIVE

BRIEF

DOE eyes AI, machine learning to accelerate long-duration energy storage research

Published Sept. 27, 2021

By Jason Plautz
Contributor

RTO Insider LLC

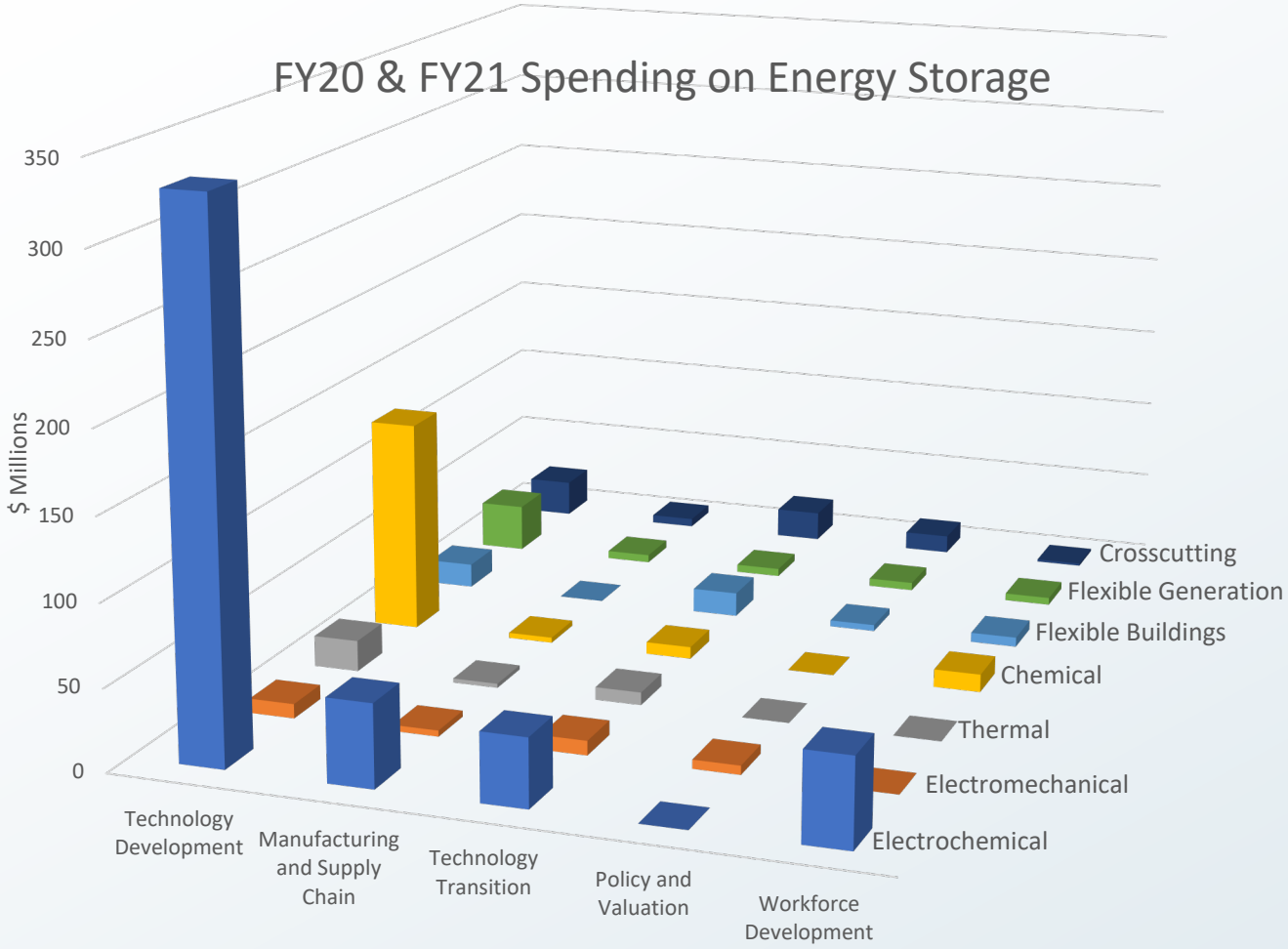
DOE Targets 90% Cut in Cost of Long-duration Storage

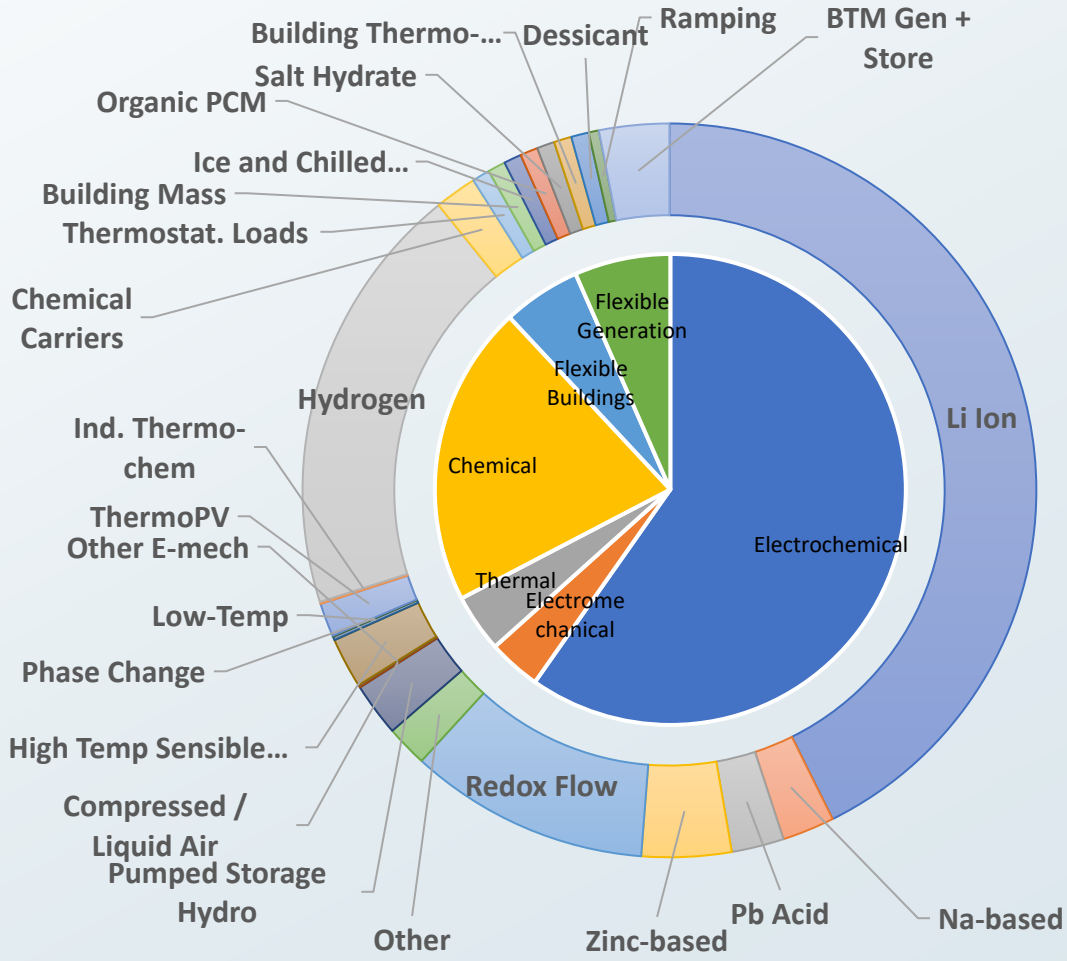
With Multiple Technologies Available, Industry Analysts Say Goal Can be Reached

Sep 27, 2021 | K Kaufmann

A new initiative at DOE's national labs will use AI and machine learning to cut the time long-duration storage technologies will need to reach commercial scale.

DOE Investment* by Technology and ESGC Track





ENERGY STORAGE GRAND CHALLENGE
U.S. DEPARTMENT OF ENERGY

*Investments include individual program and sub-program budgets of DOE offices participating in the ESGC

Focused Funding Opportunities

Office	Title	Amount	Status
EERE, OE, OP, IE, FECM, ED	Local Energy Action Program (Communities LEAP)	$16M**	**Registration opens 10/25/21 Applications Due 12/17/21**
OE	https://www.pnnl.gov/projects/energy-storage-social-equity-initiative	$9M	**Open: Applications Due 12/3/21**
EERE: AMO	Structured Electrode Manufacturing for Lithium-ion Batteries	$3M	**Open: Full applications due 11/05/21**
EERE: AMO & OE	Flow Battery Systems Manufacturing FOA	$17.9M*	Selections announced 9/23/21
NE & EERE: HFTO	Advance Technologies Integrating Hydrogen and Nuclear Power	$20M**	Closed: Submissions under review
EERE: VTO	Accelerate Advanced Vehicle Technologies Research (batteries and electrification sub-topic)	$35M*	Selections announced 7/26/21
EERE: VTO	SBIR: Electric Drive Vehicle Batteries	~$2M	Selections announced June 2021
OE	SBIR: Safety Technologies For Grid Scale Energy Storage Systems	$1.1M	Selections announced July 2021
OTT	Energy Program for Innovation Clusters (EPIC)	$9M	Selections announced May 2021
EERE: FCTO, AMO	Hydrogen and Fuel Cells R&D 2021 (High Temperature Electrolyzer Manufacturing subtopic)	$8.3M*	Selections announced 7/7/2021
EERE: BTO & OE	Connected Communities	$65M**	Closed: Submissions under review
EERE: AMO	Critical Materials FOA: Next-Generation Technologies and Field Validation	$17.7M*	Selections announced 1/20/21
FECM	Energy Storage for Fossil Power Generation	$7.6M*	Projects awarded in April 2021

*Total for ESGC related projects, ** Total amount of award, ESGC total may be less

Funding Opportunity: Flow Battery Systems Manufacturing

Next-Generation Batteries Can Help Deliver Clean, Affordable Power to Communities Nationwide.
The FOA is designed to bring manufacturable technologies from the lab to the marketplace.

Value of Flow Batteries

- **Long-duration energy storage** for grid-scale applications (from a few hours to days), providing improved grid stability, efficiency, and reliability
- **Increased scalability, design flexibility, safety, and lifespan** (over a 15–year operating life), owing to the decoupled energy storage unit and power conversion unit

Gaps and Challenges

Disparity between Technology Readiness Level (TRL), Manufacturing Readiness Level (MRL), and the supply chain's preparedness for scale-up in flow battery manufacturing. Specific challenges include:

- Inefficient and expensive manufacturing technologies
- Lack of robust, standardized supply chains (limited suppliers) and system integration challenges
- Challenges with manufacturing scale-up

Technical Scope of the FOA

Technical Scope

- Optimized flow battery component design & manufacturing for scale-up
- System assembly processes for subsystems
- Strengthening flow battery supply chains

Technical Categories

- Types of flow batteries: Multiple types of flow batteries
- Flow battery system size: Between 10 and 100 kWh to
  - De-risk the design/deployment of grid-scale system
  - Reach unmet demand for integration with residential variable energy systems and EV charging stations
- TRL and MRL: Applications that will reduce the existing disparity among TRL, MRL, and the supply chain's preparedness level for scale-up (from mid-TRL range, i.e., TRL/MRL 4 to higher TRL/MRL 6 or 7).

Expected Deliverables

- Physical prototype system
- Performance testing/validation data at multiple scales
- Enhanced system integration methodologies

Selections Announced 9/23/2021

Respective Roles of AMO and OE

Advanced Manufacturing Office (AMO) supports advancing energy storage in two ways:

- Improving the manufacturability of emerging energy storage technologies to accelerate their adoption and grow domestic manufacturing; and
- Increasing the economic competitiveness of industrial and commercial sectors by integrating energy storage into their operations.

For this FOA, DOE's AMO will fund, support, and manage the selected RDD&D (research, development, demonstration, and deployment) projects.

Office of Electricity (OE) supports the development of safe and reliable energy storage systems in large-scale deployment.

For this FOA, DOE's OE will fund the costs of final prototype testing and validation conducted at the National Laboratory facilities.

Energy Storage for Social Equity Initiative

An innovative technical assistance and technology deployment program advancing community prosperity, well-being, and resilience

Technical Assistance

Comprehensive and personalized assessments on energy storage feasibility, design, and application to help communities meet their goals

Project Development

Engineering and financial support to further develop completed Technical Assistance Assessments into tangible results

https://www.pnnl.gov/projects/energy-storage-social-equity-initiative

Major Energy Storage Developments

- In July, **Form Energy unveiled its new long-duration iron-air battery**. A 1MW/150MWh version of the system is scheduled to be deployed by Great River Energy in Minnesota in 2023.
- On 9/4, **battery modules at Vistra Corp's 300 MW Moss Landing facility overheated**, triggering fire sprinklers and causing the plant to drop offline. Vistra Corp, Fluence, and LG Chem are investigating the incident.
- On 9/10, **The Wall Street Journal** reported that big investors "are charging into startups touting experimental new battery technologies that would make it possible for renewable energy sources to produce most of the country's electricity." DOE, the article added, has "set a goal of reducing the cost of grid-scale long-duration energy storage by 90% within the decade."
- On 9/15, **Illinois enacted a 100% clean energy policy**, committing to 50% renewables by 2040 and 100% carbon-free electricity by 2045. The legislation includes a Coal to Solar and Storage Initiative that will make US$280.5 million available to energy storage projects installed at the sites of certain retiring coal plants.
- On 10/12, **ESS, which makes giant batteries out of iron, salt and water, started trading on the NYSE**.

Form Energy received support from DOE through both JCESR and ARPA-E

OE's Storage Safety program provides extensive industry engagement (domestic and international) on ESS safety issues.

Imre Gyuk talks to the WSJ's Future of Everything podcast about the Long Duration Storage Earthshot

OE's Storage program provides technical and policy support work to states, including to Illinois and throughout the Midwest region

ESS received early support from DOE through ARPA-E

Upcoming Storage Events

Title	Date	Link
DOE Office of Electricity Energy Storage Program Annual Peer Review	Oct 26-29	https://doepeerreview.sandia.gov/
Building Solutions to Address the National Energy Storage Workforce Needs	Oct 28	https://cvent.me/Vn3z8B
Measuring Success and Impact on National Energy Storage Workforce Solutions	Nov 17	https://cvent.me/Vn3z8B

https://www.energy.gov/energy-storage-grand-challenge/energy-storage-grand-challenge-public-workshops