Energy Storage Grand Challenge

Introduction and Overview

February 12, 2020
• ESGC Overview
• Track Details
  – Technology Development
  – Policy and Valuation
  – Technology Transition
The Energy Storage Grand Challenge

- Vision: By 2030, the U.S. will be the world leader in energy storage utilization and exports, with a secure domestic manufacturing supply chain independent of foreign sources of critical materials.
Mission: The Energy Storage Grand Challenge 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, through the following objectives:

- **Technology Development**
  - Establish ambitious, achievable performance goals, and a comprehensive R&D portfolio to achieve them.

- **Technology Transition**
  - Accelerate the technology pipeline from research to system design to private sector adoption through rigorous system evaluation, performance validation, siting tools, and targeted collaborations.

- **Policy and Valuation**
  - Develop best-in-class models, data, and analysis to inform the most effective value proposition and use cases for storage technologies.

- **Domestic Manufacturing and Supply Chain**
  - Design new technologies to strengthen U.S. manufacturing, recyclability, and reduce dependence on foreign sources of critical minerals.

- **Workforce Development**
  - Train the next generation of American workers to meet the needs of the 21st century grid and energy storage value chain.
DOE

Energy Storage Grand Challenge: Organizational Structure

RTIC

Energy Storage Subcommittee

Executive Champions
Paul Dabbar (S4), Bruce Walker (OE), Lane Genatowski (AR)

Executive Committee
Co-chairs: Alex Fitzsimmons, Michael Pesin

Technology Development
[Storage | Power Elect.]
(Eric Hsieh, OE)

Technology Transition
(Marcos Gonzales, OTT)

Policy and Valuation
(Alejandro Moreno, EERE)

Domestic Manufacturing
and Supply Chain
(Valri Lightner, EERE)

Workforce Development
(Linda Horton, SC)
Technology Development
Technology Development: A Use Case-Informed R&D Strategy

**Vision**
- What are your energy or infrastructure goals?
  - Home, business, community, regional
  - Potentially accelerated with next-generation storage

**Use Cases**
- Who are the beneficiaries?
- What are the performance requirements?
- What are other technical or deployment constraints?
- What technologies could meet the use case need?
- Can substantial progress (cost, performance) be made by 2030?

**Technologies**
- What is the R&D pathway to achieving commercial viability?
- What DOE resources (consortia, partnerships, test facilities, programs) would be utilized to accelerate each technology?
Use Case Mapping to Technology Pathways

“Guidepost” Use Cases

Disaster Resilience and Recovery
Dependent Network Infrastructure
Facilitating An Evolving Grid
Remote Communities
Electrified Transportation
Facility Flexibility, Efficiency and Value Enhancement

Tech Neutral Requirements

Performance
• Duration
• Cycles per Year
• Ramp Rate
• Response Time
• Lifetime

Operations
• Temperature
• Moisture
• Saline Resistance
• Emissions Runtime
• Noise Limits
• Flammability Risk

Delivery, Installation, Connection
• Shipping weight limits
• Construction season
• Interconnection voltage

Technology Pathways

Bidirectional Electrical Storage
Thermal and Chemical Storage
Flexible Generation and Controllable Load
Advanced Power Electronics
Cross-cutting research consortium

Application-aware development capability

Performance and safety testing capability

Demonstration and validation program

Manufacturing scale program

ESGC: Accelerate the Path from Concept to Commercialization

Increasing Market Readiness

Foundational Science

Materials R&D

Materials scaling

Device Prototyping

Component Validation

Scalable Manufacture

Controls Interop.

Large Scale Testing

Commercial Validation

Market Access

High-Value Deployments

Wide Bankability

Increasing Levels of Integration

Materials

Device

BOP + Power Electronics

Grid Integration

Investment

Operations

Value/Revenue

End of Life

DOE

Technology Pathway Example: Concept to Commercialization

HydroWIRES (ANL, INL, NREL, ORNL, PNNL)

DOE Applied R&D (Most NL’s)

AMO Battery, PE (ORNL)

GMLC Metrics (PNNL, LBNL, NREL)

GMLC Device Testing (Sandia, NL, NREL)

Pumped-Storage Technology Development (ANL, INL, NREL, ORNL, PNNL)

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GMLC DER Controls (PNNL, LLNL, INL, Sandia)

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Sample Storage Ecosystem: Electrochemistry Acceleration

**Increasing Levels of Integration**

- **Materials**
- **Device**
- **BOP + Power Electronics**
- **Grid Integration**
- **Investment**
- **Operations**
- **Value/Revenue**
- **End of Life**

**Increasing Market Readiness**

- Foundational Science
- Materials R&D
- Materials scaling
- Device Prototyping
- Component Validation
- Scalable Manufacture
- Controls Interop.
- Large Scale Testing
- Commercial Validation
- Market Access
- High-Value Deployments
- Wide Bankability

**Grid Storage Launchpad, PNNL**
- Performance Validation of Storage Electrochemistries
- Scale: “Button-cell” to 100 KW

**Battery Abuse Testing Lab, SNL**
- Energy storage system safety
- Scale: Packs and modules to systems

**Grid Research Integration and Deployment Center, ORNL**
- System-level dynamic and efficient interactions
- Scale: batteries + power electronics to systems

**Energy Storage Research Center, Southern Research**
- Vendor and pre-deployment system validation
- Scale: turnkey systems
Industry Input into Technology Development Strategy

Energy and infrastructure and goals

• [Project 2X nexus]

Next-gen storage acceleration of those goals

ESGC Use Cases

R&D, manufacturing objectives

Leverage from DOE resources

ESGC Technology Pathways
Policy & Valuation
Proposed revised mission statement:

Provide tools, analysis and recommendations that maximize the value of energy storage to the electric and transportation systems and drive U.S. leadership in storage innovation, manufacturing, and commercial use.

Why does policy and valuation matter to storage?

Energy storage has the potential to offer significant value to the U.S. economy as both an end-use product and a source of industrial competitiveness.

But there are substantial barriers that prevent the full realization of that value and could slow the growth of the sector that require new policies, regulations, and analytical understanding to overcome.
Policies are limited by incomplete understanding of:

- **What can storage do?** Technical capabilities and lifecycle costs
- **What is it worth?** The value of different services under different conditions
- **How to integrate, operate, and pay for it?** Planning, operation and compensation of storage in the power system

**Who does this affect?**

- PUCs
- ISO/RTOs
- States
- Utilities
- Developers
- Consumers
- Manufacturers
- DOE

**What is the result?** Rules and policies that limit the value, compensation, and deployment of storage
**Example: Valuation of Storage to Resiliency**

**Current gaps and impact**

**Gap:** The value of bulk and distributed storage resources to power system resilience is poorly understood.

**Outcome:** Limited understanding of resilience may lead to underrepresentation of storage in power system planning, insufficient compensation for storage systems, and regulations that do not encourage optimization of storage for system resilience.

**Stakeholder Impacts:**

- **PUCs/ISOs:** Develop regulations, rules, market products that artificially limit storage’s contribution to resilience.
- **Utilities:** Storage is not included in IRPs, or is incorporated in ways (e.g., size, location, operations) that do not reflect its resilience value.
- **Developers:** Lack of compensation for resilience value leads to under-deployment or limited resilience benefits.
- **DOE & R&D Organizations:** Reduced investment in technologies and configurations that maximize resilience.

**Research Needs:**

- Valuation of resilience
- Technical assessment of storage systems’ abilities to provide black-start, other resilience services
- Assessment of storage configurations, system architecture

**Models:****

- NAERM
- Improved representation of storage in capacity expansion and dispatch models

**Data:**

- Cost and performance data of storage, alternatives
- Costs of outages, vulnerability

Assessing the contribution of storage to resilience requires understanding the ability of different storage characteristics to provide resilience services, and the value of those under a wide range of power system conditions, structures, and generation/load mixes.
### Implementation

DOE has many efforts that can help address these challenges – some examples:

#### OE Storage Regulatory Engagements and TA
- Informational workshop and technical assistance to states evaluating energy storage deployments.
- TPTA Technical Assistance Program

#### OE Storage Analysis
- Analytic tools for utilities and regulatory agencies to facilitate planning and implementation of energy storage in transmission and distribution infrastructure.

#### GMLC Analysis and Institutional Support
- Institutional support framework for PUCs, ISOs/RTOs
- Framework for valuation of grid services, grid architecture
- Demonstration of storage contribution to black-start (Plum Island)

#### EERE Strategic Programs (SPIA) Analysis
- Improved representation of storage in capacity expansion models
- Evaluation of long duration storage, hybrid systems
- Storage futures study
- Annual Technology Baseline

#### Individual EERE Offices
- Solar: Solar + storage for resilience; Integration costs of BTM storage + PV; SHINES demo projects
- Hydro: Storage data (w OE); valuation guidelines/tool for PSH; storage in power models; hydro in micro-grids, hydro + batteries
- Fuel Cells: H2@scale for grid storage
- Wind: grid services from grid and utility-scale wind + storage
- OWIP: State Energy Program
How can these products be delivered? Systematic policy support and technical assistance to critical organizations, supported by best-in-class analysis based on up-to-date data and improved models.
Technology Transition
Energy Storage Grand Challenge: Technology Transition Track

- Develop Collaborative Relationships and Knowledge-sharing Tools
  - Market Analysis

- Pursue Demonstration Projects
  - Interagency/External Engagement

- Ensure Bankable Projects via Predictable Revenue Streams
  - Request for Information (RFI)
DOE-branded Publication to:

- Inform DOE strategy
- Signal government support to external counterparts
- Inform investors, entrepreneurs, companies, policymakers, regulators, and the general public
- Track rapid changes over time
- Highlight DOE deep-dive analyses and work products
- Integrate disparate technologies and applications into an overarching framework
- Serve as a basis for discussion and feedback

Evaluate fundamental market drivers:
- Consumer preferences
- Addressable markets
- Financial risk & opportunity
- Scenario analysis
- Competitive positioning
- VC & investment trends
- Technology potential
- Supply chain & costs

Energy.gov/technologytransitions
The Office of Technology Transitions (OTT) advances the economic, energy, and national security interests of the United States by expanding the commercial impact of the Department of Energy’s research and development portfolio.

It streamlines access to information and to DOE’s National Labs and facilities — fostering partnerships that guide innovations from the lab into the marketplace.

**OTT Offers a *Menu of Options* to increase the ROI on Taxpayer R&D Dollars**

Energy.gov/technologytransitions
The TCF provides matching funds with private partners to promote promising energy technologies for commercial purposes

OTT manages the execution of the Technology Commercialization Fund (TCF), as mandated by Sec 1001 of EPAct 2005. The initial round of funding was provided in FY 2016

FY 2016

$19.7M in TCF funding to 54 projects (out of more than 100 proposals) proposals funded at 12 national labs ($15.9M), including matching funds ($16.9M) from 52 private-sector partners

FY 2017

54 projects from 136 proposals funded at 12 national labs ($19M), with matching funds ($34M) from more than 30 private-sector partners

FY 2018

64 projects from over 100 proposals (over $20M) with matching funds ($18M) from nearly 50 private-sector partners

FY 2019

77 projects from over 160 proposals ($24M) with matching funds ($25M) from more than 90 private-sector partners

Continued execution of a TCF evaluation, which tracks the FY 2016, 2017 and 2018 projects to assess processes/management and to ascertain program outcomes and effectiveness

Monitoring the progress of activities funded in previous rounds

OTT is constantly investigating new ways to improve TCF design and function.

Energy.gov/technologytransitions
- **20** Labs/Plants
- **157** Experts
- **196** Facilities
- **1,173** Technology Summaries
- **38,000+** Patents/Applications

Labpartnering.org

Energy.gov/technologytransitions
OTT Collects, Analyzes, and Reports Unclassified National Lab Tech Transfer Data

[This comprehensive data set includes sensitive information, but OTT staff are available to support program information requests. Data is available by research taxonomy, partner type, agreement type, partner location, and other parameters.]

Examples of Recent Uses

- Annual Congressional Report on Utilization of Federal Technology
- For CESER Front Office – all DHS-funded Strategic Partnership Projects at the Labs
- For IA in support of S1 Trip to Israel – all Israeli public/private entities with partnership projects with our Labs
- For S4 to prepare for Congressional meeting with Ohio Delegation – all Ohio entities with active partnership projects with our Labs

Notes:
The FY17 Data set does not yet include reporting from NNSA Labs
The FY18 Data set should be available by Spring 2019

EERE Relevant Agreements by Lab Type

Ohio: FY17 Technology Transfer Overview
- Non-Federal Partners
  - 67 agreements
  - 39 unique partners
  - $2.1 MM total partner-funds-in
  - $3.0 MM DOE-funds-in on 20 CRADAs
- Federal Partners
  - 11 agreements
  - $1.4 MM Federal partner-funds-in
  - 3 unique Federal organizations
Strategy Development Process: Timeline

- Use Case Criteria and Metrics
- National Lab Working Meeting
- Informal Stakeholder Outreach
- Regional Workshops: Seattle, Austin, Chicago
- Use Case Library
- Use Case Finalization
- DC Stakeholder Workshop March 26
- R&D Strategy Finalization
- Initial 2030 R&D Roadmap April
- Public RFI
- Deliverables
- Process