DOE

Energy Storage Grand Challenge

Introduction and Overview

February 12, 2020

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Presentation Outline

- **ESGC Overview**
- **Track Details**
  - Technology Development
  - Policy and Valuation
  - Technology Transition

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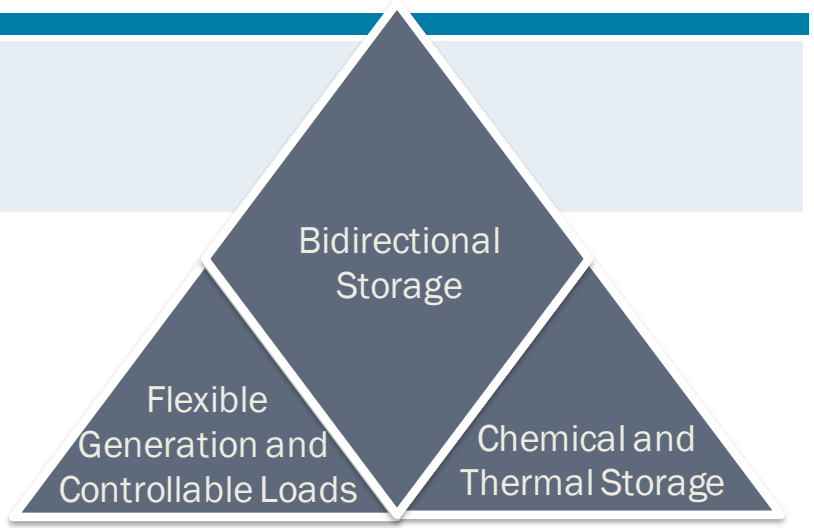
The Energy Storage Grand Challenge

- 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



Science

ARPA-E

EERE

OE

NE

FE

OTT

LPO

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

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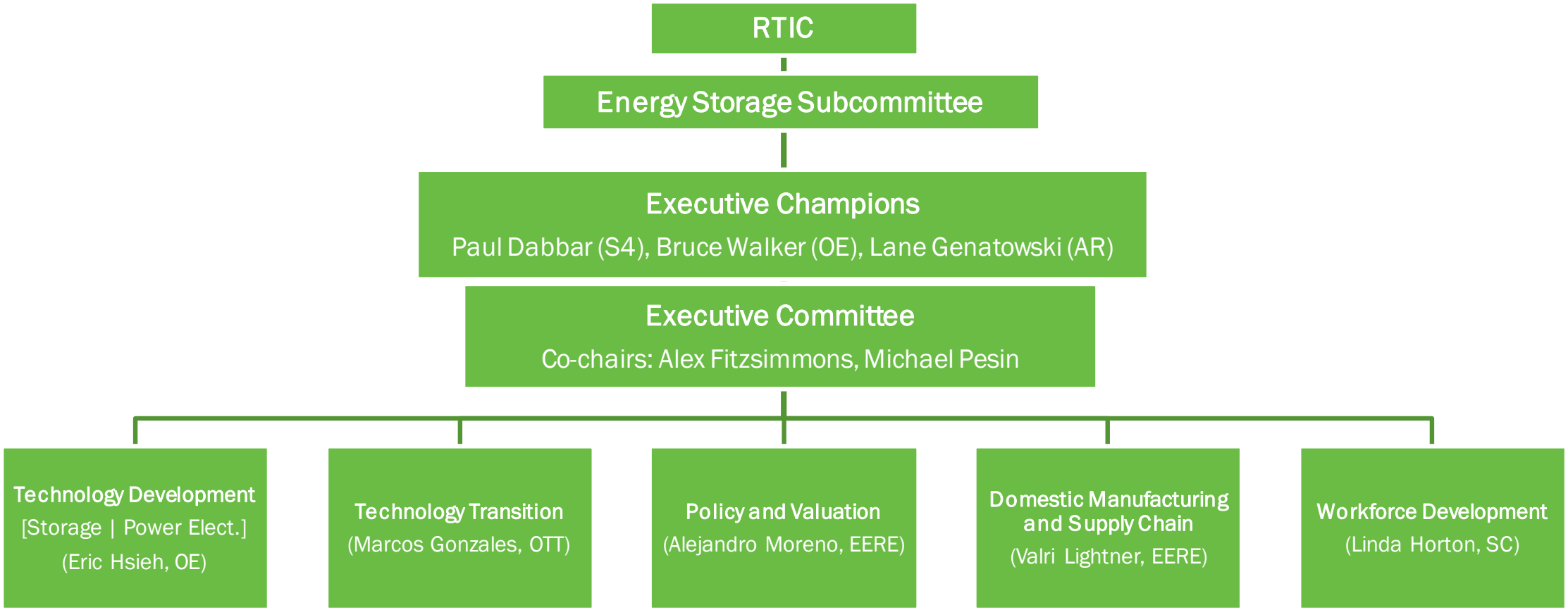
Energy Storage Grand Challenge Focus Areas

- **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	Technology Transition	Policy and Valuation	Domestic Manufacturing and Supply Chain	Workforce Development
• Establish ambitious, achievable performance goals, and a comprehensive R&D portfolio to achieve them.	• Accelerate the technology pipeline from research to system design to private sector adoption through rigorous system evaluation, performance validation, siting tools, and targeted collaborations	• Develop best-in-class models, data, and analysis to inform the most effective value proposition and use cases for storage technologies.	• Design new technologies to strengthen U.S. manufacturing, recyclability, and reduce dependence on foreign sources of critical minerals	• Train the next generation of American workers to meet the needs of the 21st century grid and energy storage value chain

Energy Storage Grand Challenge: Organizational Structure



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Technology Development

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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?

Technologies

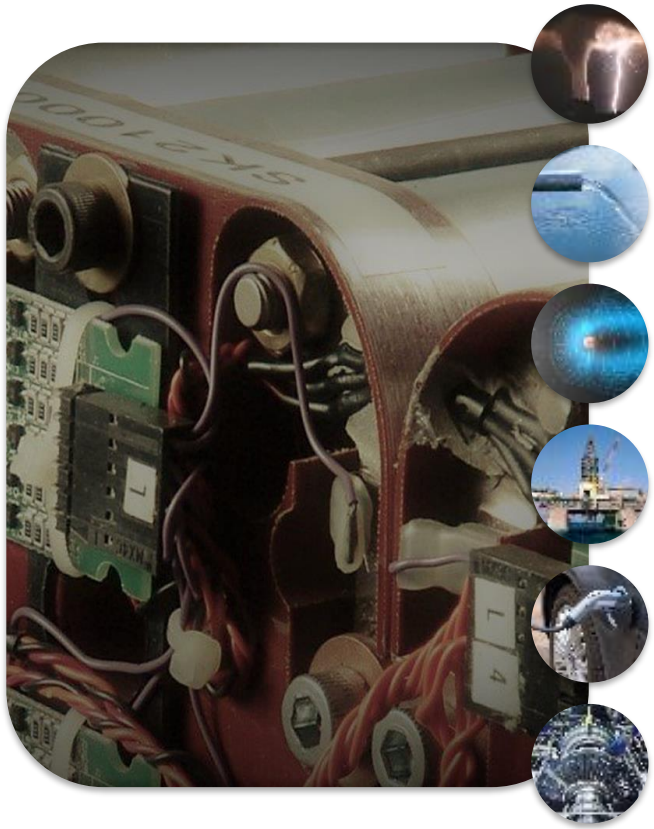
- What technologies could meet the use case need?
- Can substantial progress (cost, performance) be made by 2030?

Pathways

- 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

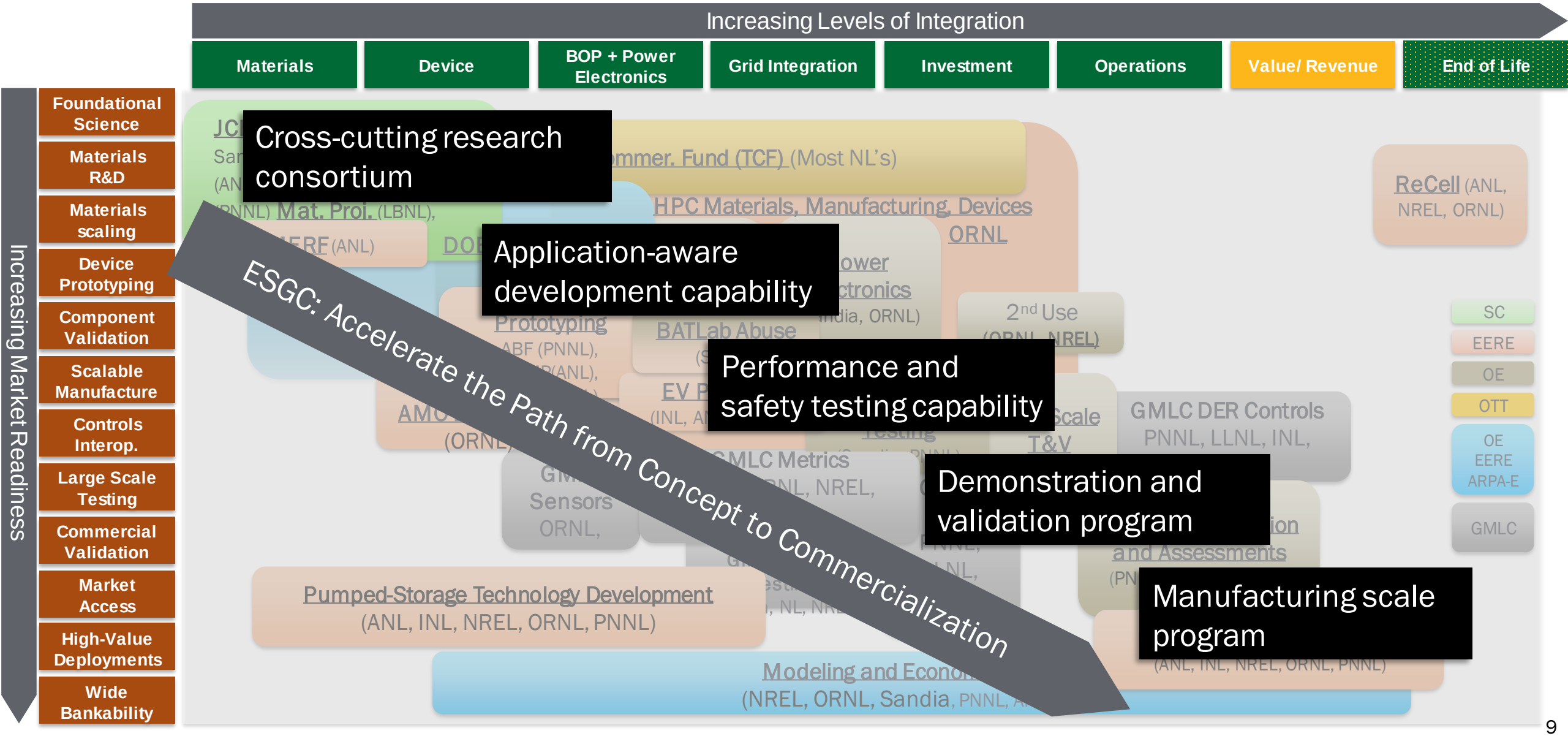
Tech Neutral Requirements

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

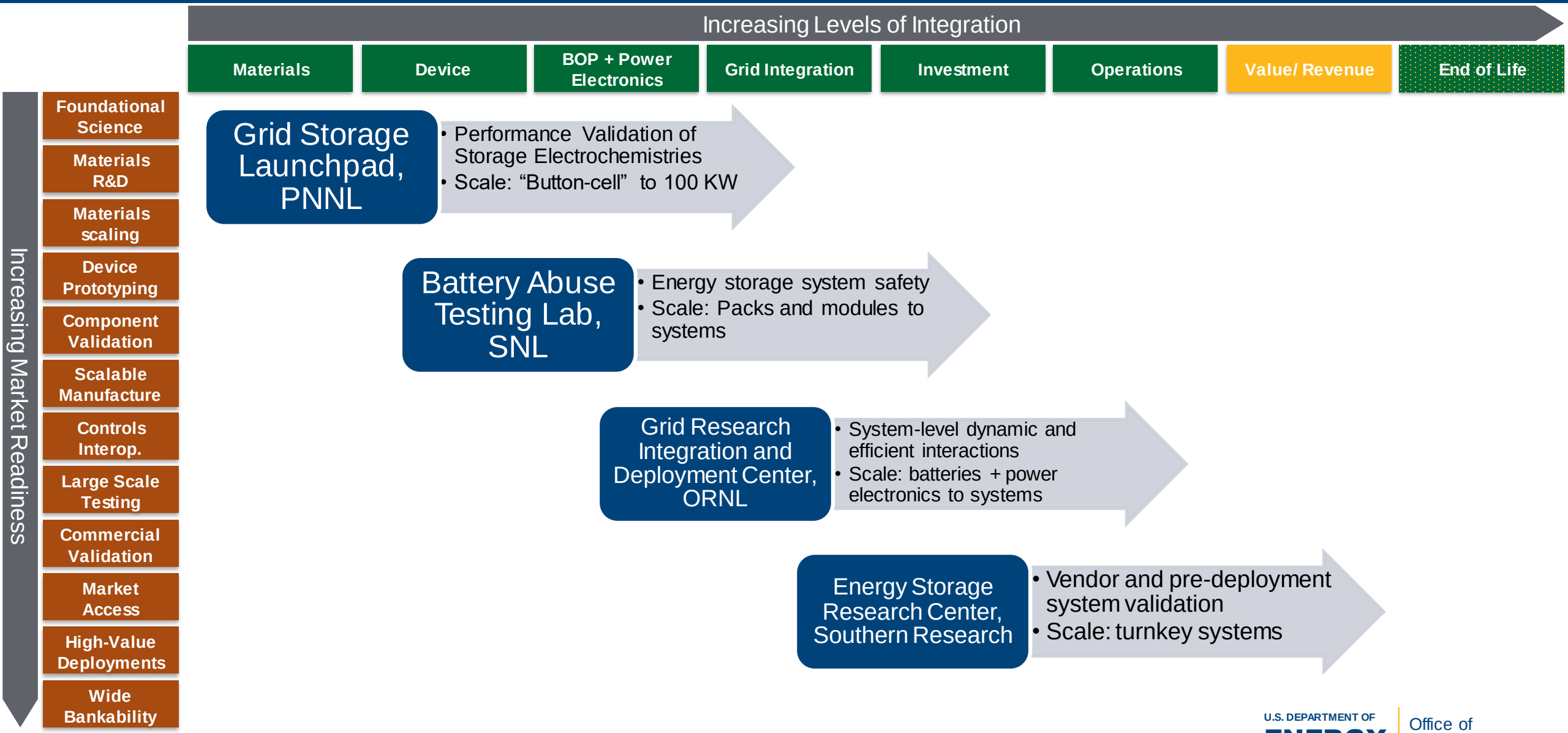
Technology Pathways

- Bidirectional Electrical Storage
- Thermal and Chemical Storage
- Flexible Generation and Controllable Load
- Advanced Power Electronics

Technology Pathway Example: Concept to Commercialization



Sample Storage Ecosystem: Electrochemistry Acceleration



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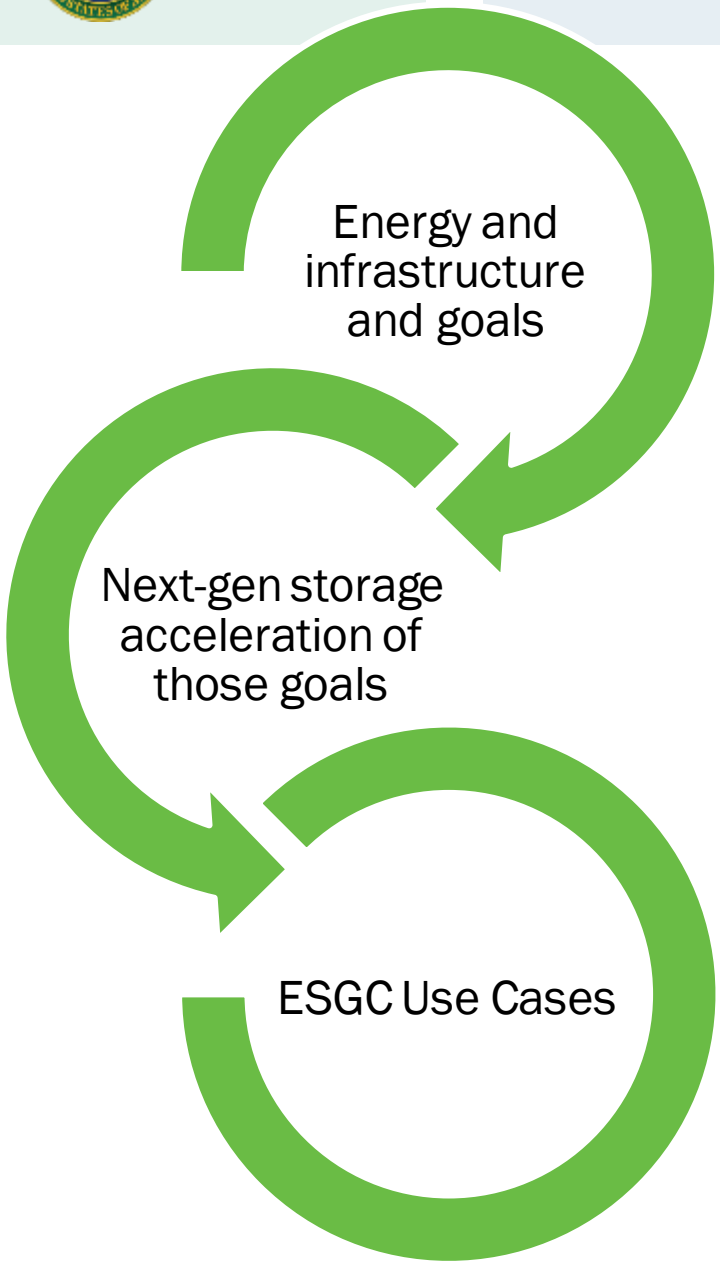
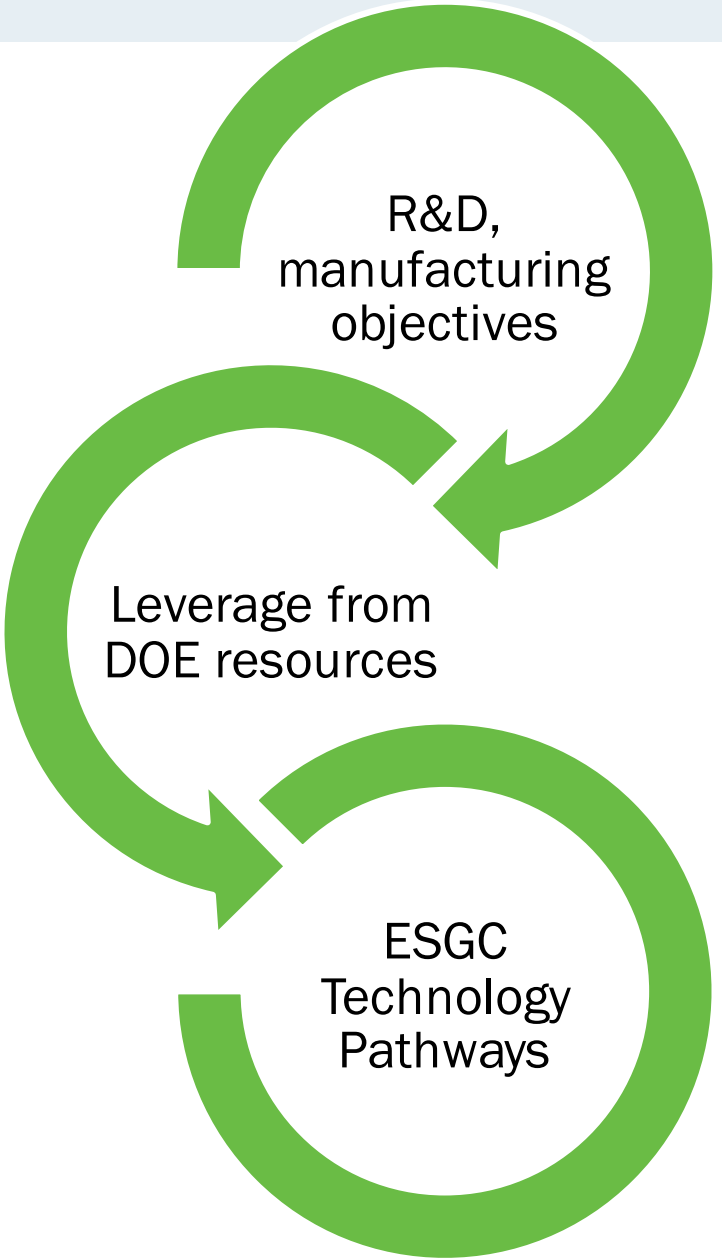
Industry Input into Technology Development Strategy



- [Project 2X nexus]



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Policy & Valuation

Policy and Valuation: Purpose and Rationale

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.

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Policy and Valuation: Getting Policies and Regulations Right

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

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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:

Analysis
- 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.

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Policy and Valuation: Existing DOE Work (Examples)

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)

EIA

- Improved representation of storage in capacity expansion models
- Annual Energy Outlook

EERE Strategic Programs (SPIA) Analysis

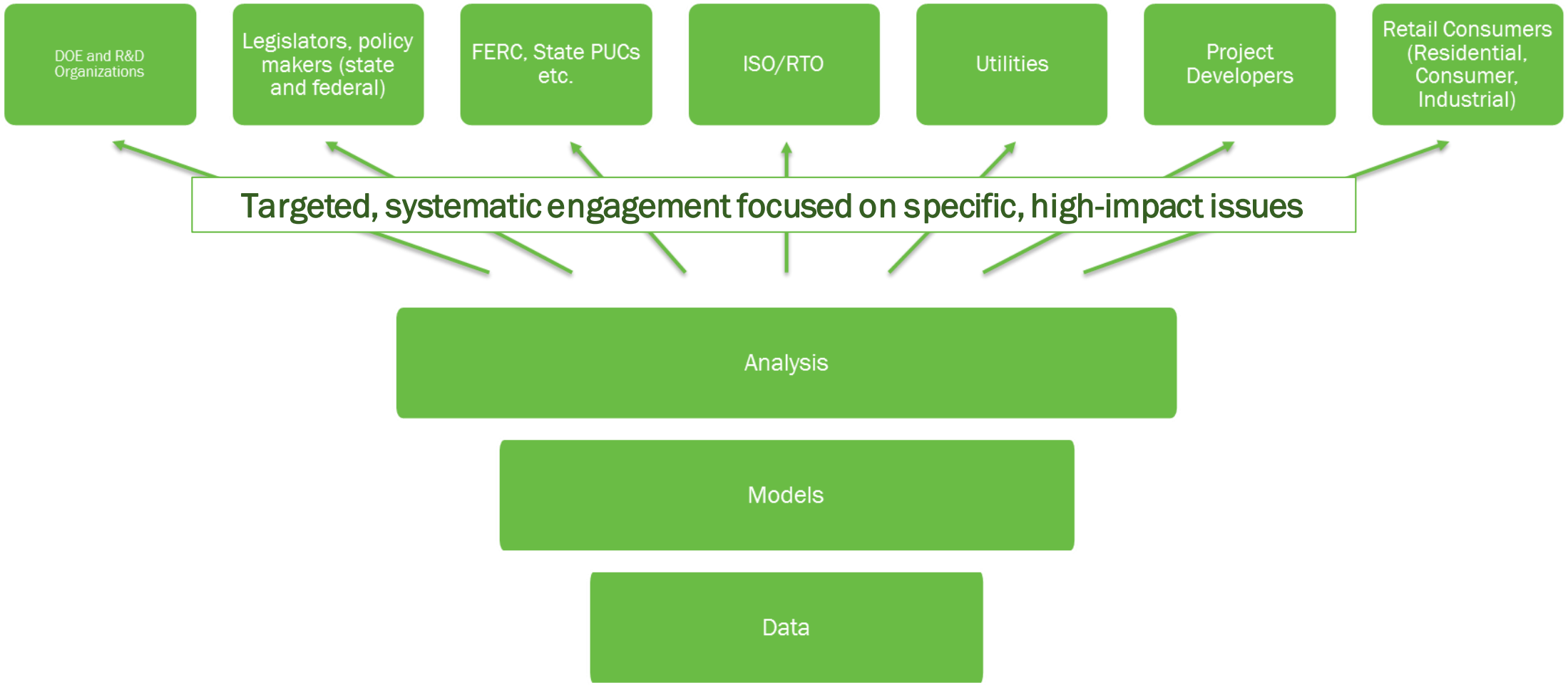
- Improved representation of storage in capacity expansion models
- Evaluation of long duration storage, hybrid systems • Storage futures study • Annual Technology Baseline

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

Policy and Valuation: DOE Role - Delivery

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



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Technology Transition

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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

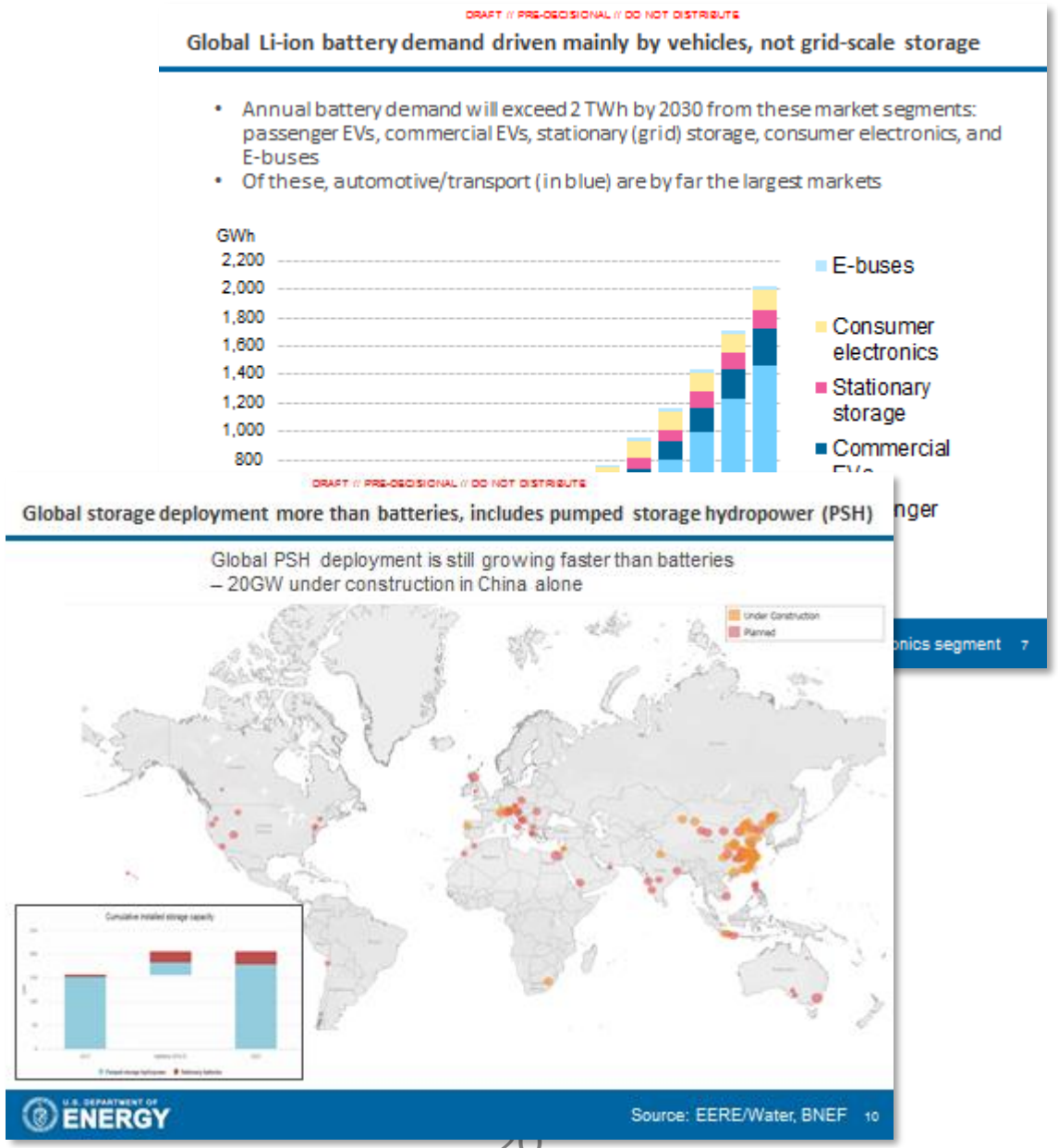
- Request for Information (RFI)

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

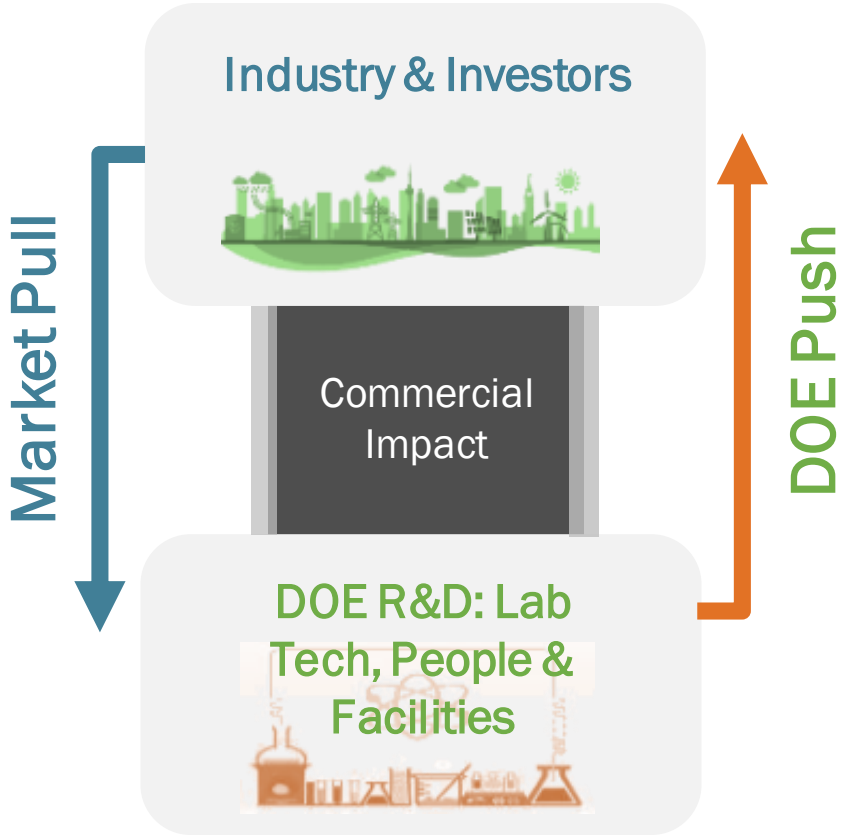
Evaluate fundamental market drivers:

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



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

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**

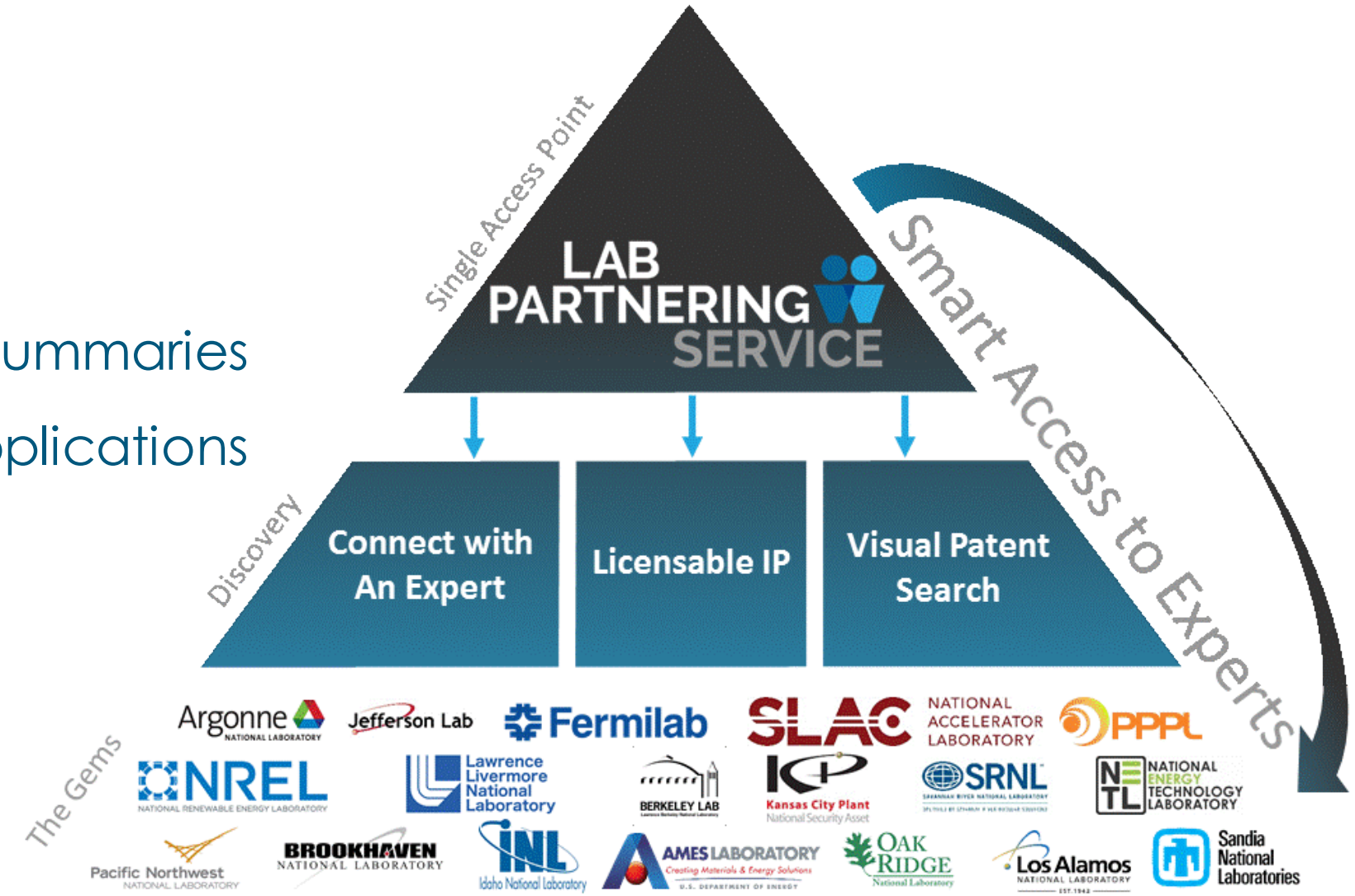
Continued execution of a **TCF evaluation,** which tracks the FY 2016, 2017 and 2018 projects to assess processes/management and to ascertain program outcomes and effectiveness

Monitoring the progress of activities funded in previous rounds

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

- 20 Labs/Plants
- 157 Experts
- 196 Facilities
- 1,173 Technology Summaries
- 38,000+ Patents/Applications

Labpartnering.org



OTT Collects, Analyzes, and Reports Unclassified National Lab Tech Transfer Data

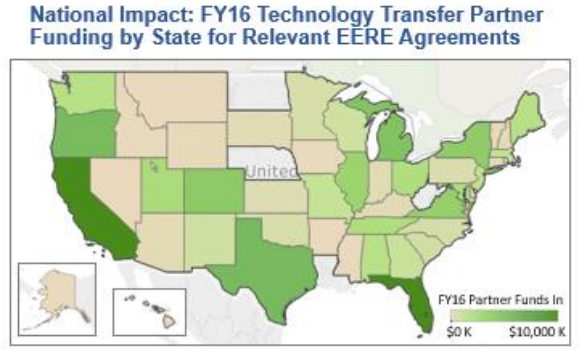
[This comprehensive data set includes sensitive information, but OTT staff are available to support program information requests. Data is available by research taxonomy, partner type, agreement type, partner location, and other parameters.]

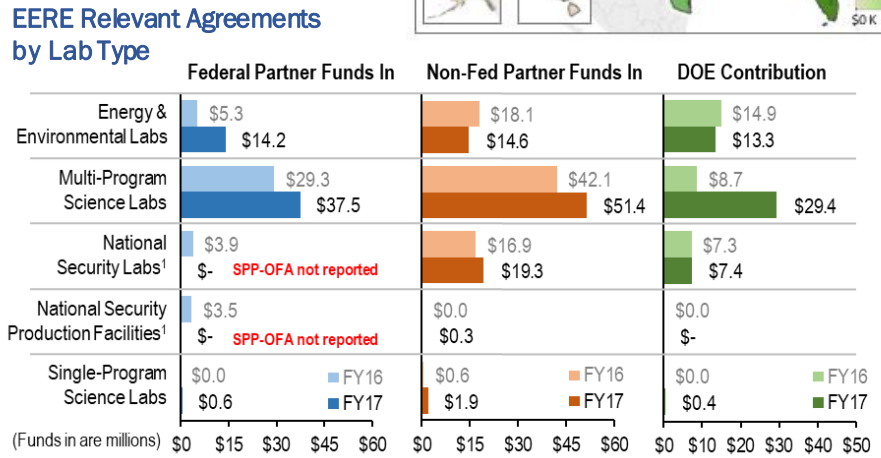
Examples of Recent Uses

- ✓ 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, broken out at the county and district level.

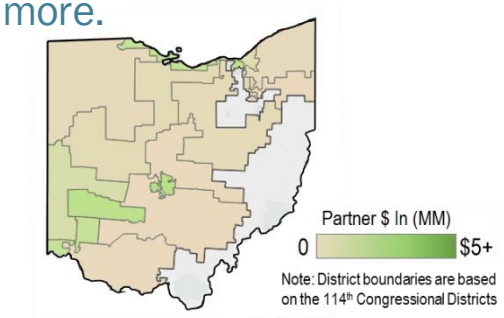
Notes:
The FY17 Data set does not yet include reporting from NNSA Labs
The FY18 Data set should be available by Spring 2019

OTT's tech transfer data set is used to provide program specific insights…





… to prepare for Congressional meetings, and more.



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