U.S. DEPARTMENT OF ENERGY

Energy Storage Grand Challenge

Overview Workshop

MAY 1, 2020

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Welcome and Opening Remarks

Alex Fitzsimmons

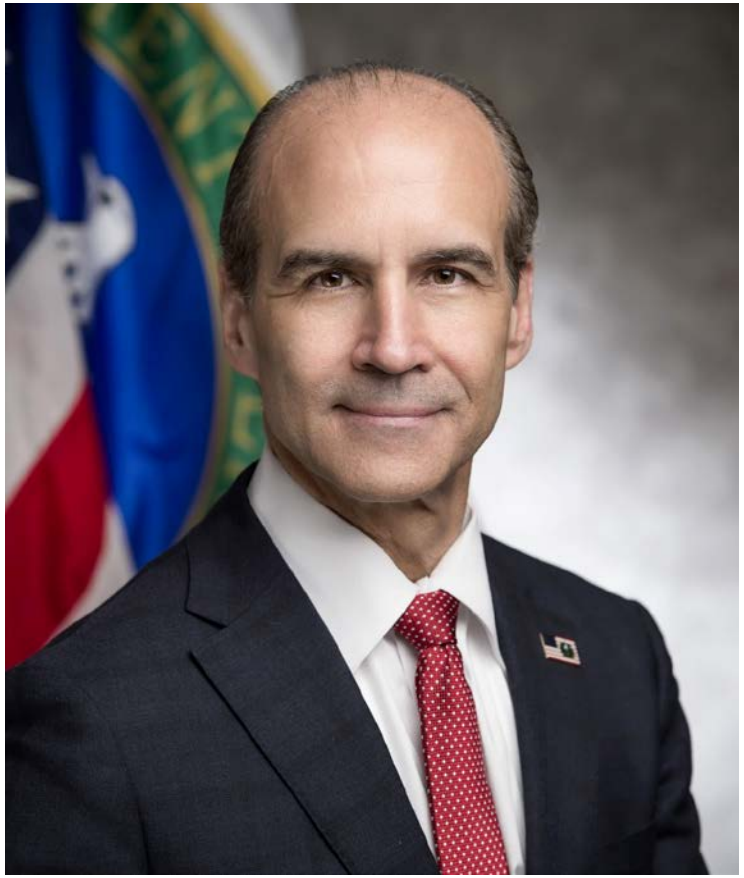
Deputy Assistant Secretary

Office of Energy Efficiency and Renewable Energy

Keynotes

Mark Menezes

Undersecretary of Energy



Keynotes

Daniel R Simmons

Assistant Secretary

Office of Energy Efficiency and Renewable Energy

Keynotes

Bruce Walker

Assistant Secretary
Office of Electricity

Questions

Please submit your questions in the Chat box to the host.

Energy Storage Tracks

Energy Storage Tracks

Panelists

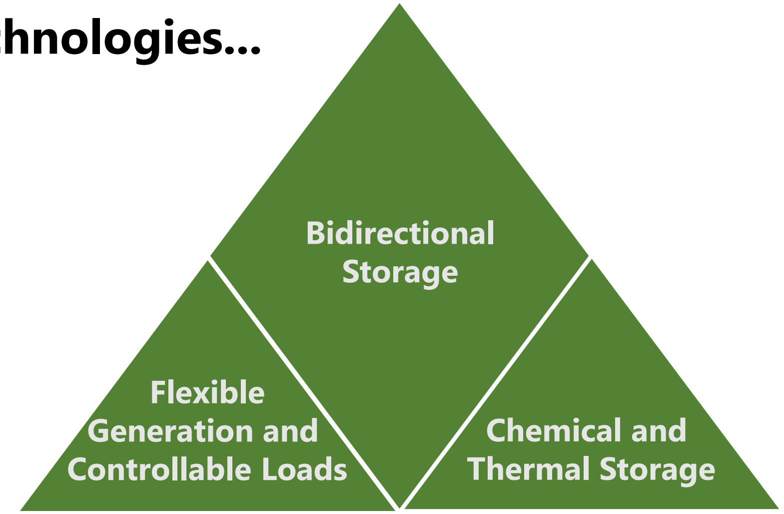
- Technology Development: Eric Hsieh, Office of Electricity
- Manufacturing and Supply Chain: Diana Bauer, Office of Energy Efficiency and Renewable Energy
- Technology Transition: Stephen Hendrickson, Office of Technology Transitions
- Policy and Valuation: Alejandro Moreno, Office of Energy Efficiency and Renewable Energy
- Workforce Development: John Vetrano, Office of Science

ESGC Vision, Mission, and Scope

DOE-wide strategy to accelerate US leadership in energy storage technologies

Coordinated across DOE:

technologies…



…offices…

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

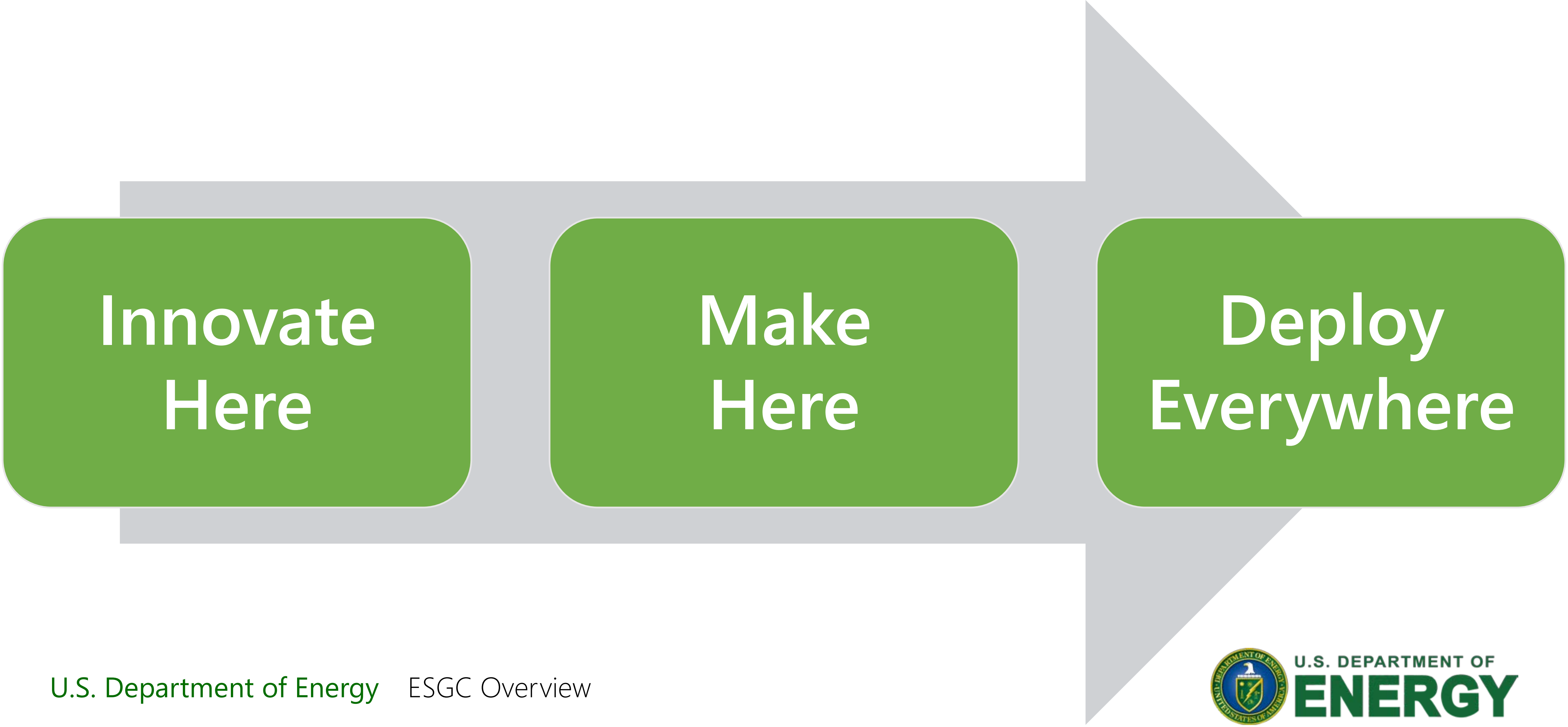
…and functions.

ESGC Focus Areas

How to achieve "Innovate Here, Make Here, Deploy Everywhere"

Technology Development	Domestic Manufacturing and Supply Chain	Technology Transition	Policy and Valuation	Workforce Development
• Establish ambitious, achievable performance goals, and a comprehensive R&D portfolio to achieve them.	• Design new technologies to strengthen U.S. manufacturing, recyclability, and reduce dependence on foreign sources of critical minerals.	• 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.	• Train the next generation of American workers to meet the needs of the 21st century grid and energy storage value chain.

ESGC in Summary



Technology Development

Eric Hsieh

Technology Development

The Technology Development track will focus DOE's ongoing and future storage R&D around user centric goals and long-term leadership.

Purpose:

Develop and implement an R&D ecosystem that strengthens and maintains U.S. leadership in energy storage innovation.

Need:

Proactive and coordinated DOE actions will be required to develop the new tools and technologies that accelerate energy storage development.

Mission:

The ESGC will create a framework of capabilities and programs that maximize the pace of storage innovation through improved performance and decreased cost.

Technology Development

Technology Development is focused on "Innovate"

Successful innovations depend on understanding deployment

Innovate Here → **Make Here** → **Deploy Everywhere**

Technology Development

Steps to a DOE-wide R&D framework

1. Use cases as R&D guideposts
2. Diverse technology portfolio
3. Pathways to accelerate new technologies

1. Use Case-Informed R&D Framework

Vision

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

Use Case Framework

- Who are the beneficiaries?
- What are the performance requirements?
- What are other technical or deployment constraints?

Technology Portfolio

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

Accelerate 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?

Updated Biannually

Facilitating an Evolving Grid

Scope	• The U.S. electric power system
Major Drivers	• Increasing adoption of variable renewable energy • Dynamic changes in customer demand • Weather, physical, and cyber threats
Success Statement	• 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.

Beneficiaries	• Utilities, balancing authorities
	• Localities, states, regions
	  • With high carbon-free electricity mandates
	  • Facing increasing external threats

Brattle estimated the benefit of distribution investment deferral at $14/kW-year [in Texas]; Edgette et al. estimated $104/kW-year [in Minnesota]; Maitra et al. estimated $9/kW-year [in the LADWP area]

Balducci, Patrick J., et al. "Assigning value to energy storage systems at multiple points in an electrical grid." Energy & Environmental Science 11.8 (2018): 1926-1944.

"…energy storage capacity costs below a roughly $20/kWh target would allow a wind-solar mix to provide cost-competitive baseload electricity in resource-abundant locations…"

Ziegler, Micah S., et al. "Storage requirements and costs of shaping renewable energy Toward grid decarbonization." Joule 3.9 (2019): 2134-2153.

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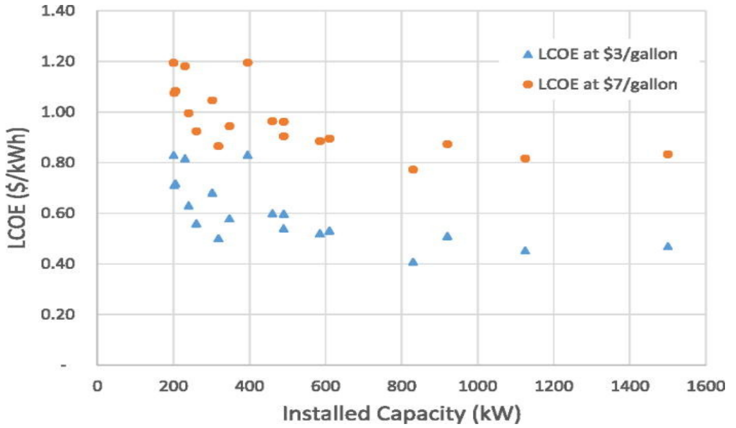
Serving Remote Communities

Scope	• Island, coastal, and remote communities
Major Drivers	• Electricity premium due to fuel logistics and maintenance • Fuel supply disruptions
Success Statement	• Clean, resilient, and cost-effective storage and flexibility solutions to provide electricity for critical and beneficial public services.

Beneficiaries	• Communities
	  • without current electrical infrastructure
	  • power provided by delivered fuel
	  • bulk power connections are not practical or economically unfeasible
	• Remote Department of Defense locations
	• Grid connected regions to improve local resiliency and flexibility

Levelized cost of electricity for Alaskan Communities under different fuel costs



Nathan Green; Marc Mueller-Stoffels; Erin Whitney; Journal of Renewable and Sustainable Energy 9, 061701 (2017) DOI: 10.1063/1.4986585

"Oregon's Office of Emergency Management encourages people to be prepared to be on their own for a minimum of two weeks."

https://www.oregon.gov/OEM/hazardsprep/Pages/2-Weeks-Ready.aspx

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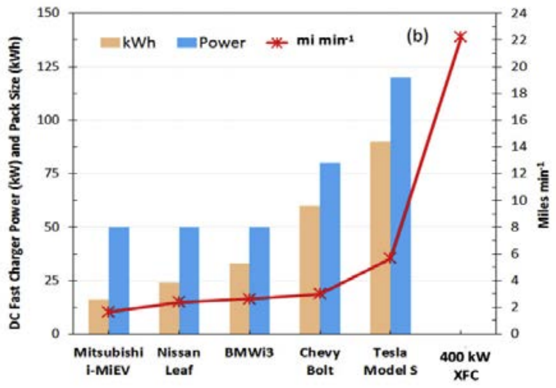
Electrified Mobility

Scope	• Charging infrastructure • Energy storage systems for electric vehicles
Major Drivers	• Fast charging can stress the delivery capacity of the local distribution grid • Opportunity for lower manufacturing costs and improved performance of electric vehicle batteries
Success Statement	• Clean and cost-effective storage solutions that facilitate a large-scale adoption of electric vehicles while maximizing beneficial coordination with the power grid.

Beneficiaries	• Fleet owners, including
	  • Department of Defense
	  • Delivery companies, logistics operators
	  • Emergency and first responders
	• Electric utilities
	• End consumers
	• New business models, such as charging station operators



"During high use times, multiple XFC events may occur either simultaneously at a single location or back-to-back at the same location. An effective energy storage solution would need to be able to buffer both the power and energy demands of such a station."

USDOE, "Enabling Fast Charging: A Technology Gap Assessment" October 2017

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Interdependent Network Infrastructure

Scope

- Other infrastructure sectors critical to the electric grid, including
  - Natural gas and water
  - Communications, information technology, financial services

Major Drivers

- Interdependencies mean loss of function and service within these infrastructure can have far-reaching costs and impacts

Success Statement

- Cost-effective storage solutions that sustain and enhance normal operations amidst short term disruptions of energy inputs.

Beneficiaries

- Owner-operators of critical infrastructure equipment and systems

"Most telecommunications facilities have at least eight-hour backup— often required by regulation—but locations prone to lengthy power outages, such as hurricane-prone areas, require backup capability between 24 and 72 hours."

https://www.hydrogen.energy.gov/pdfs/44520.pdf

Critical Service Resilience

Scope	• Critical sectors, including: • Defense • Emergency Services • Government Facilities • Healthcare and Public Health • Companies, manufacturers, who need to maintain operations
Major Drivers	• Disaster-related and other power outages
Success Statement	• Cost-effective storage solutions that maintain critical services for a sufficient duration following extended power outages.
Beneficiaries	• Owners, operators, and users of critical sector facilities • Residents and businesses relying on critical services

"At a minimum MDLARA will require that sufficient on-site fuel storage be available to provide… demand for at least 24 hours."

Michigan Department of Licensing & Regulatory Affairs
Requirements For Emergency Fuel In Hospitals
https://www.michigan.gov/documents/mdch/Emergency_Fuel_and_Water_Supply_for_Hospitals_199271_7.pdf

Requirements regarding onsite fuel source during emergency [for FL Assisted Living Facilities]:

- 16 beds or less = 48 hours
- 17 or more beds = 72 hours

http://jchc.virginia.gov/5.%20Assisted%20Living%20Facilities%20-%20Generator%20Requirement%20FINAL.pdf

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Facility Flexibility, Efficiency, and Value Enhancement

Scope	• Commercial and Residential Buildings
Major Drivers	• Enhance the overall facility value to the owner, operator and the end consumer
Success Statement	• Storage and flexibility solutions that deliver net benefits including energy expenditures, comfort, and functionality.
Beneficiaries	• Commercial and residential building owners, operators, and occupants

"In an effort to save taxpayers money…GSA has enrolled approximately 25 MW of load in demand response programs and receives about $1 million in annual benefits." [$40/kw-yr equiv.]

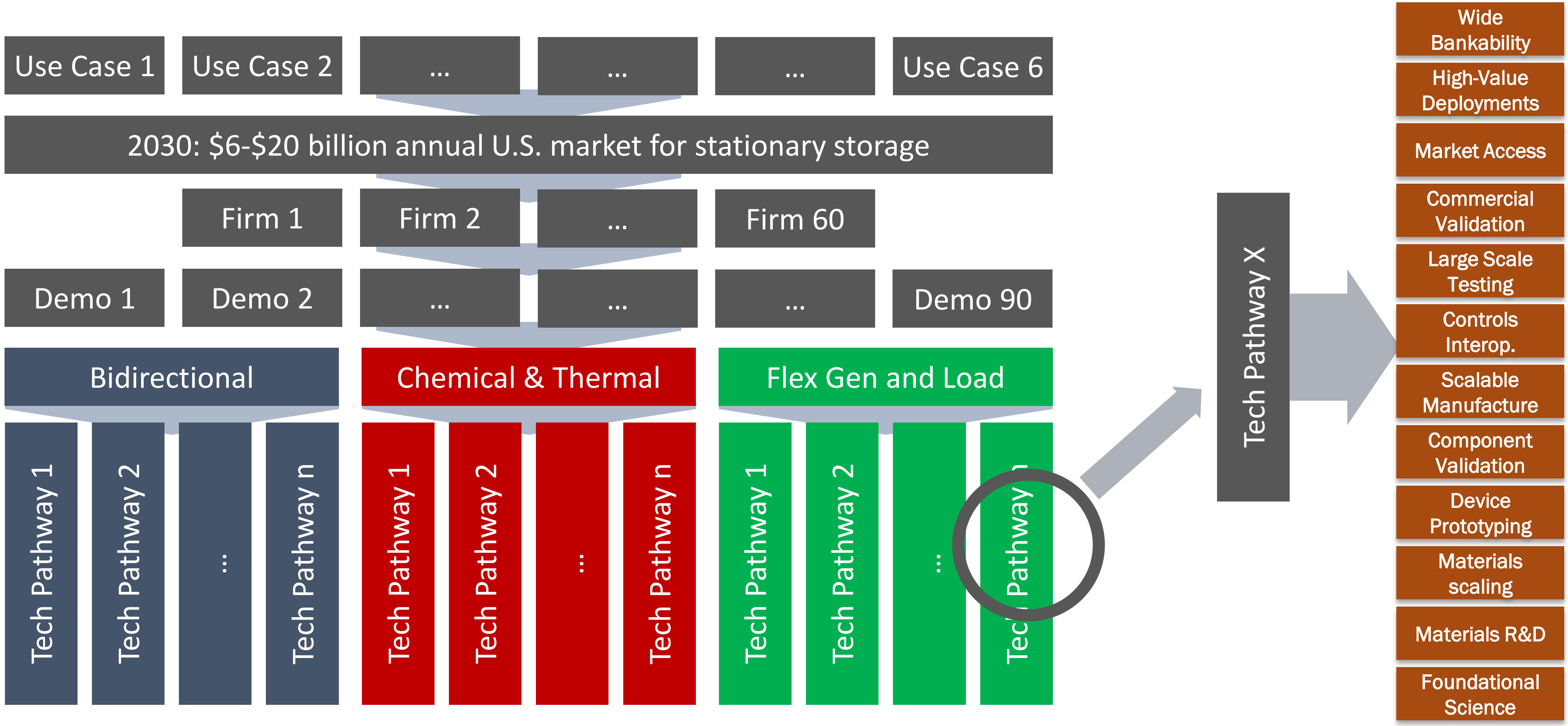
https://www.ferc.gov/legal/staff-reports/2019/DR-AM-Report2019.pdf

Scope	• Energy-Intensive Facilities, including • Electric Power Generation • Industrial Process Applications
Major Drivers	• Opportunities for improvement in economics, flexibility, and market diversity
Success Statement	• Storage and flexibility solutions that maximize the total value obtained from the process of interest.
Beneficiaries	• Utility plant owners, operators and shareholders • Industry plant owners, operators, and shareholders

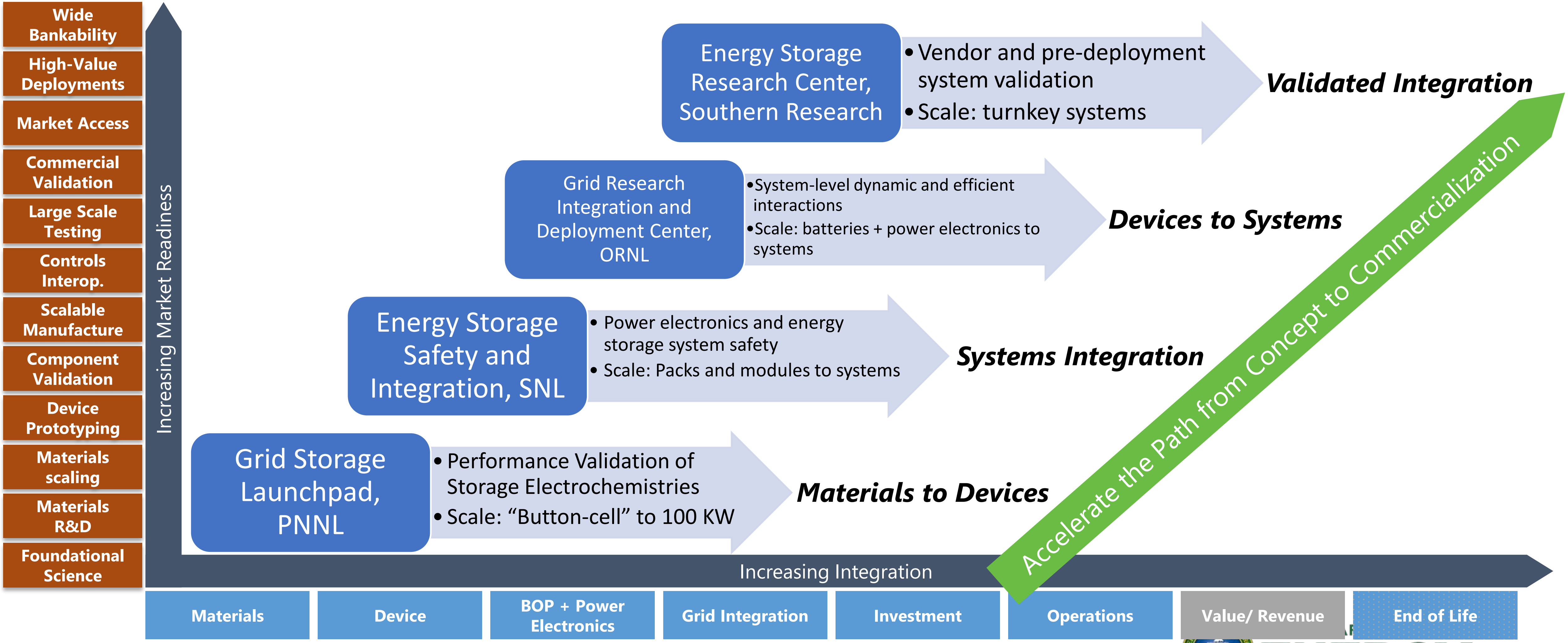
"Upgrades to increase the maximum output, decrease the minimum output, increase the ramp limit, and combinations of all features would lead to a greater increase in net revenues under…a recent proposal by PJM to reform its reserve market."

https://www.eme.psu.edu/sites/www.eme.psu.edu/files/rewarding_flexibility_pjm_final_1.pdf

2. Technology Portfolios: 2030 U.S. Storage Industry Scenario



3. Pathway Example: DOE Electrochemical Storage Capabilities



ENERGY

Activities

Mission: "Maximize the pace of storage innovation."

1. **Use Cases:** Develop and maintain use cases that identify storage uses, benefits, and functional requirements for 2030 and beyond
2. **Technology Portfolios:** Assemble a diverse technology portfolio with the potential to meet the functions identified in the use cases
3. **Development Pathways:** Leverage DOE and industry capabilities to create accelerated innovation pathways

Summary

Purpose: Strengthen the *Innovate Here* ecosystem

By strengthening the connections between all R&D stages and end user benefits, the ESGC aims to accelerate the entire storage innovation process.

Manufacturing and Supply Chain

Diana Bauer

Manufacturing and Supply Chain

Purpose:

Build and diversify a strong domestic manufacturing base with integrated supply chains to support U.S. energy storage leadership.

Need:

To fully capture the benefits of energy storage technologies, the United States needs a robust manufacturing enterprise that can drive down costs, rapidly integrate and scale production of innovations, and reliably source critical materials and components.

Mission:

Pursue a coordinated strategy that prioritized and integrates investments to:

- Address major technical barriers in manufacturing of energy storage materials, components, and systems to lower costs and improve performance
- Accelerate scale up of manufacturing innovations from laboratory bench to demonstrate commercialization
- Enable reliable sourcing of critical materials and components across supply chains

Manufacturing and Supply Chain

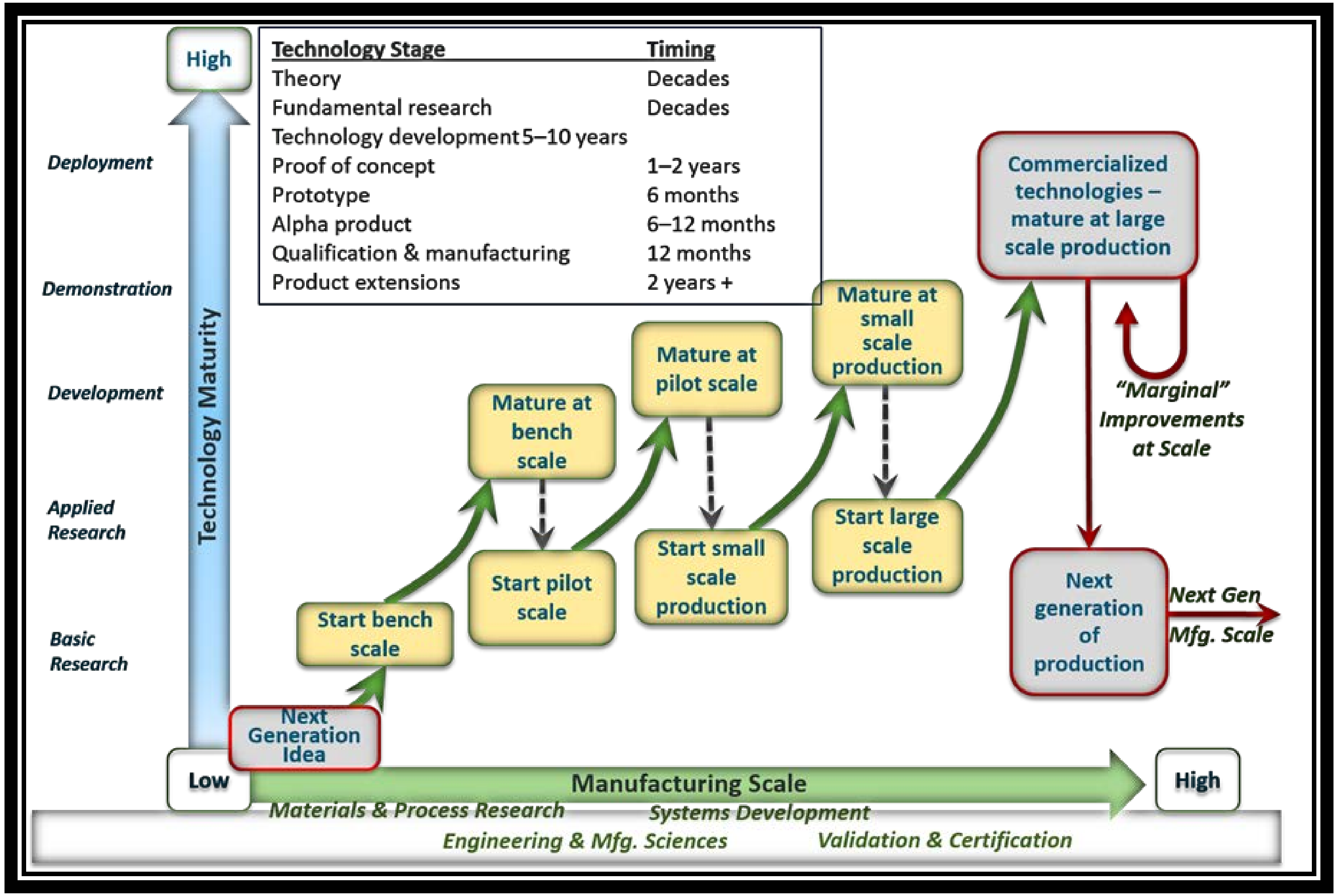
Manufacturing and supply chains are focused on “Make Here,” addressing manufacturing scale-up, reduced domestic manufacturing cost, improved performance, and domestic supply chain resilience

Innovate Here

Make Here

Deploy Everywhere

Technology Maturity and Manufacturing Scale Pathways



Exploring Technologies and Supply Chains

Meeting the ESGC goal will require a combination of research and technology development across the manufacturing supply chain.

Raw materials → Refined materials → Component manufacturing → Energy storage system manufacturing → End user → Recycling/ Reuse/ Disposal

R&D AREAS

- Manufacturing process intensification
- Critical materials processing and separations
- Roll-to-roll manufacturing capabilities
- Membrane manufacturing processes
- New materials for harsh service environments and corresponding manufacturing processes

POTENTIAL TECHNOLOGIES

- Lithium-based batteries
- Non-lithium-based solid-state batteries
- Flow batteries
- Compressed air energy storage
- Pumped hydro
- Hydrogen generation and storage
- Synthetic fuels (e.g., synbiogas)
- Thermal energy storage
- Combined heat and power

March Manufacturing Webinar

Breakout Sessions:

- Electrochemical energy storage
- Flow batteries
- Chemical energy storage
- Thermal energy storage
- Industries as storage

Identified cross-cutting manufacturing challenges:

- Membranes
- Bipolar plates
- Hybrid systems
- Grid integration technologies, such as power electronics
- Raw material availability
- Translating low TRL innovations to high TRL prototypes

Addressing Technical Barriers in Manufacturing

C H A L L E N G E S

1. **Lowering manufacturing cost for components**
   Membranes
   Anodes
   Cathodes
   Electrolyzers
   Materials
   Containment Structures

2. **Reducing manufacturing barriers to improve performance**
   Advanced Materials
   Bipolar Plates
   Heat Exchangers
   Others

A C T I O N S

1. **Technology assessment studies** for energy storage and related technologies
2. **R&D investments across multiple offices** to improved performance and lower the cost to manufacture for materials and components

Accelerating Manufacturing Scale-Up

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Technical challenges to scaling up and integrating emerging technologies from lab to prototype to commercialization

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Scale up actions focused on:

1. Thermal storage
2. Li-based batteries
3. Grid scale deployment

Improving Critical Materials Supply Chain Resilience

CHALLENGE

Fragmented supply chain for lithium and cobalt in batteries

ACTIONS

1. R&D on lithium processing and separations innovations
2. R&D on batteries with reduced cobalt requirements
3. Innovations in battery recycling

Preview of RFI Questions

- What are the most pressing challenges for scaling up the manufacture of energy storage systems?
- What are the most pressing challenges to maintaining a strong, fully domestic supply chain for energy storage?
- What materials or components represent the largest barriers to directly lowering the cost of production for total energy storage system?
- Which manufacturing methods would provide the greatest impact for energy storage technology?
- What energy storage manufacturing and supply chain policies would help establish and maintain manufacturing capacity within the U.S.?

Technology Transition

Stephen Hendrickson

Technology Transition

Purpose:

Strengthen U.S. leadership in energy storage through the commercialization and deployment of energy storage innovations.

Need:

Proactive field validation, public private partnerships, bankable business model development, financing, technology and interconnection standards, contract standards, and the dissemination of high-quality market data to enable the commercialization, private sector financing, and deployment of energy storage technologies.

Mission:

To realize the vision of U.S. energy storage leadership, the Technology Transition track accelerates the technology pipeline from research to system design to private sector adoption through validation, financing, and collaboration.

Technology Transition

Identify options to expand the innovation pipeline and commercialize more technologies

Leverage federal gov't tools and resources to enable U.S. firms to compete in markets around the world

Innovate Here

Make Here

Deploy Everywhere

Requires significant private sector investment

Accelerate Commercialization

The Technology Transition track will explore the full range of commercialization pathways and identify activities to support and potentially accelerate their development.

These pathways include the use cases described previously:

- Facilitating an Evolving Grid
- Serving Remote Communities
- Electrified Mobility
- Interdependent Network Infrastructure
- Critical Service Resilience
- Facility Flexibility, Efficiency, and Value Enhancement

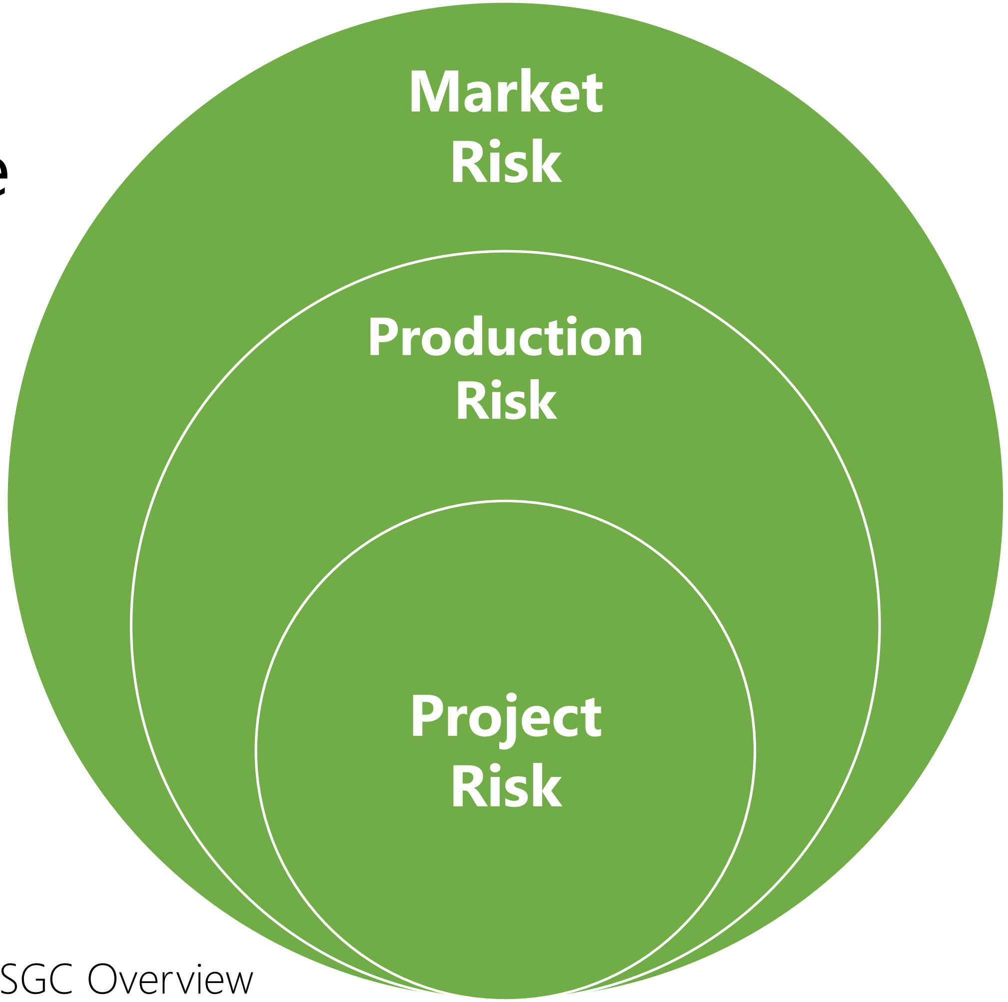
Innovate Here

Identify options to expand the innovation pipeline and commercialize more technologies

- Finance early-stage technologies
- Identify potential applications
- Explore business models
- Assess market potential

Make Here

Commercialization and deployment of new energy storage technologies requires significant private sector investment.



The deployment of energy storage technologies at scale requires de-risking projects to attract increasing level of investment.

Deploy Everywhere

U.S. leadership in energy storage requires a strategy that leverages a range of federal government tools and resources to enable U.S. firms to compete in markets around the world.

- Varying use cases, each with their own technical and cost requirements
- Domestic and international markets
- Multi-pronged approach to maximize chance of success
- Numerous decision makers: customers, investors, manufacturers, entrepreneurs, policymakers, regulators

Use Cases

- *Facilitating an Evolving Grid*
- *Serving Remote Communities*
- *Electrified Mobility*
- *Interdependent Network Infrastructure*
- *Critical Service Resilience*
- *Facility Flexibility, Efficiency and Value Enhancement*

Activities

1. **Connect** lab experts to external partners.
2. Conduct **Request for Information** (RFI) to solicit public input.
3. Expand the **Lab Partnering Service** to reduce barriers for external parties to use DOE capabilities and assets.
4. Leverage the **Technology Commercialization Fund** (TCF) to pursue energy storage opportunities.
5. Leverage the **Practices to Accelerate the Commercialization of Technologies** (PACT) projects to pursue energy storage commercialization opportunities.

Activities

6. Develop **real-world projects** to demonstrate technology and provide data for validation and standardization.
7. Pursue **industry collaboration**, innovative financing mechanisms, demonstration projects, and public private partnerships.
8. Pursue **interagency engagement** to coordinate activities to accelerate commercialization and deployment of energy storage technologies.
9. Develop **collaborative relationships** and **knowledge-sharing tools.**
10. Provide **industry and market analysis** to support investment, market formation, and policymaking activities.

Summary

Innovate Here: Identify options for expanding the innovation pipeline and commercializing more technologies.

Make Here: Commercialization and deployment of new energy storage technologies requires significant private sector investment.

Deploy Everywhere: The deployment of energy storage technologies at scale requires de-risking projects to attract increasing levels of investment.

U.S. leadership in energy storage requires a strategy that leverages a range of federal government tools and resources to enable U.S. firms to compete in markets around the world.

The Technology Transition track will pursue a suite of activities to support U.S. leadership in the global energy storage markets.

Thank you

Stephen Hendrickson

Program Manager

Office of Technology Transitions

U.S. Department of Energy

stephen.hendrickson@hq.doe.gov

Policy and Valuation

Alejandro Moreno

U.S. DEPARTMENT OF ENERGY

Policy and Valuation

Purpose:

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.

Need:

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.

Mission:

Leverage the Department's unique analytical capabilities, data and computing resources to support policy and regulatory decision-makers. Develop a coordinated DOE-wide program to develop new data, tools and analysis that allow energy sector policy and decision-makers to maximize the value of storage in the electricity, transportation, buildings, and industrial sectors.

Policy and Valuation

Policies to drive U.S.-based storage innovation, align market incentives with high-value needs

Innovate Here

Make Here

Targeted policy can encourage domestic manufacturing; incentives for secure supply chains and material reuse

Deploy Everywhere

Policy, regulations, and market rules to ensure value of storage is recognized and accurately compensated and incentivized

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 value, compensation, and storage deployment.

Key Issues

Resilience	Defining resilience and measuring energy storage technologies' ability to improve system and end-use resilience accounting for different threat types, probabilities, outage durations, costs, and system/facility characteristics
Power System Operations	Improving the representation of storage technologies (including hybrid configurations) in power flow, system stability, and optimal dispatch tools. Enhance tools' and planning processes' ability to capture interactions between the bulk-power, distribution, and transportation assets
Energy System Planning	Identifying how much, where, and what duration future DER, bulk-power, transmission, non-wire-solutions, and transportation-related storage investments are needed given potential generation mixes, infrastructure constraints, weather conditions, technology costs/availability, etc.
Transportation & Cross-Sector	Determining how can transportation-related energy storage systems (electric and fuel cell vehicles) provide services to the grid and or other end-users? How can other types of energy storage (H_2, CH_4, etc.) be valued, especially if they have end-use applications, interactions, and interdependencies across sectors?

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DOE's Role

DOE has the analytical capabilities, data and computing resources, and institutional credibility to inform more effective and cost-effective policy and regulatory decisions.

Caveat: DOE does not make policy, but offers policymakers the tools to most effectively meet their own policy and regulatory goals.

But in order to be effective, DOE policy and valuation support must be:

- **Targeted** at the most pressing policy barriers or regulatory challenges, and the specific information gaps that prevent them from being addressed
- **Systematic** in proactively working with decision-makers to identify and provide all the information needed to enable effective decisions, rather than ad hoc support for targets of easiest opportunity
- **Coordinated** across relevant offices in DOE, to ensure the right areas of expertise are applied to a given question and avoid conflicting information on a given topic
- **Informed and objective,** with support to decision-makers closely linked to the analysis informing it and avoiding any appearance of supporting one technology or office's mission over another's

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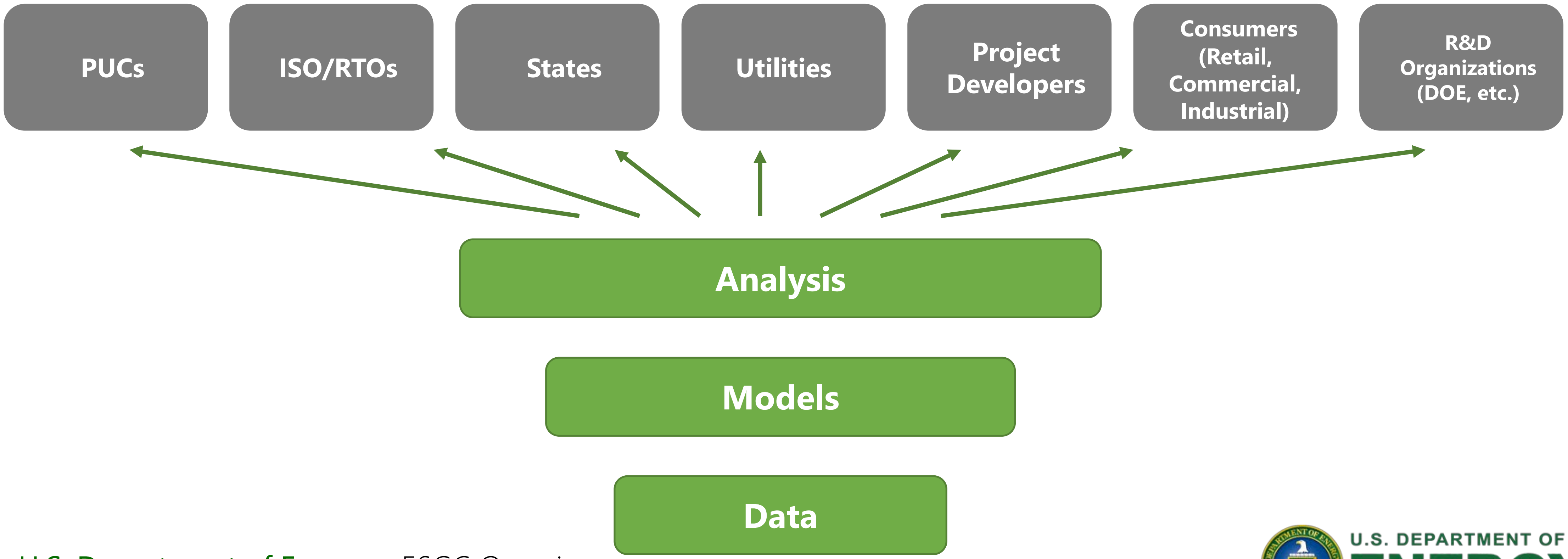
DOE Role - Delivery

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.



Existing DOE Work (Examples)

Implementation: DOE has many efforts that can help address these challenges:

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

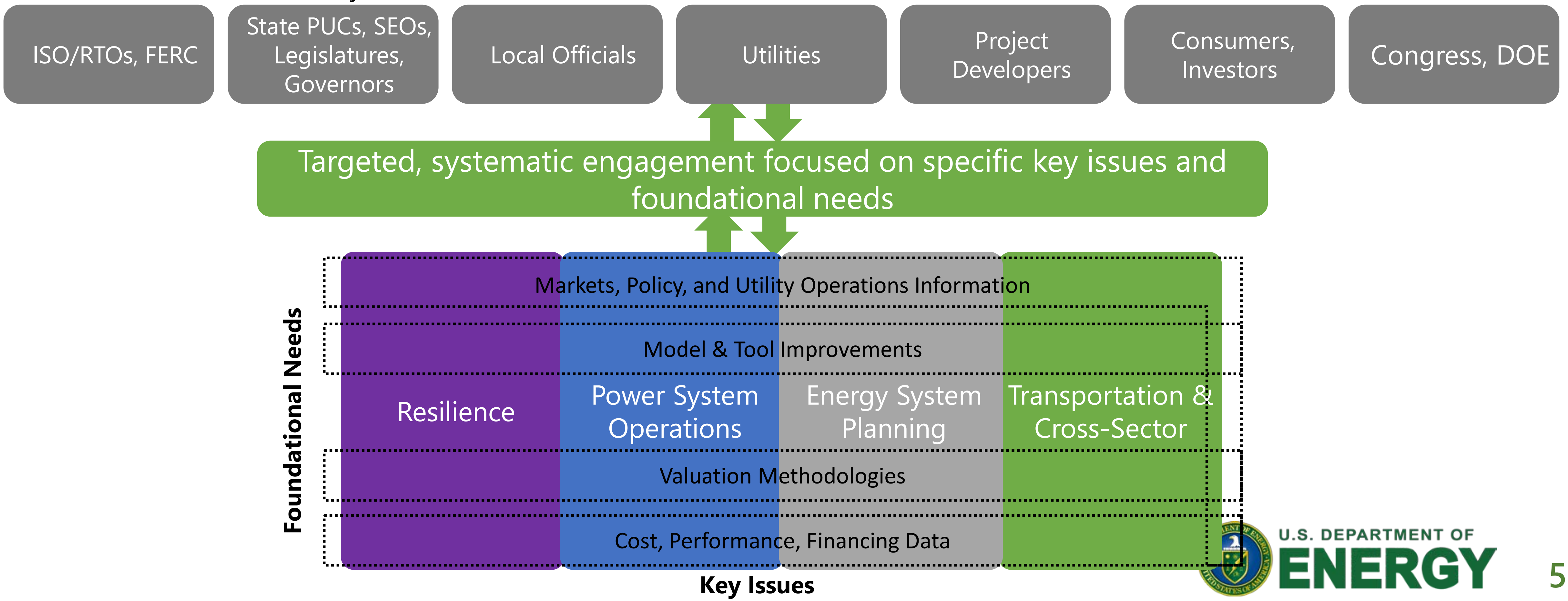
- Improved representation of storage in capacity expansion models
- Evaluation of long duration storage, hybrid systems • Storage futures study • Annual Technology Baseline

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

Delivery

How can these products be delivered? Providing a program of systematic engagement and decision-making support to critical organizations supported by best-in-class analysis based on up-to-date data and improved models to address key issues and foundational needs.



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Workforce Development

John Vetrano

Workforce Development

To grow and strengthen the energy storage industries in the United States, the existence or development of a strong and dedicated workforce will be a key building block for success and DOE has a role to play in that effort.

Purpose:

Focus DOE's technical education and workforce development programs to train and educate a workforce needed for energy storage.

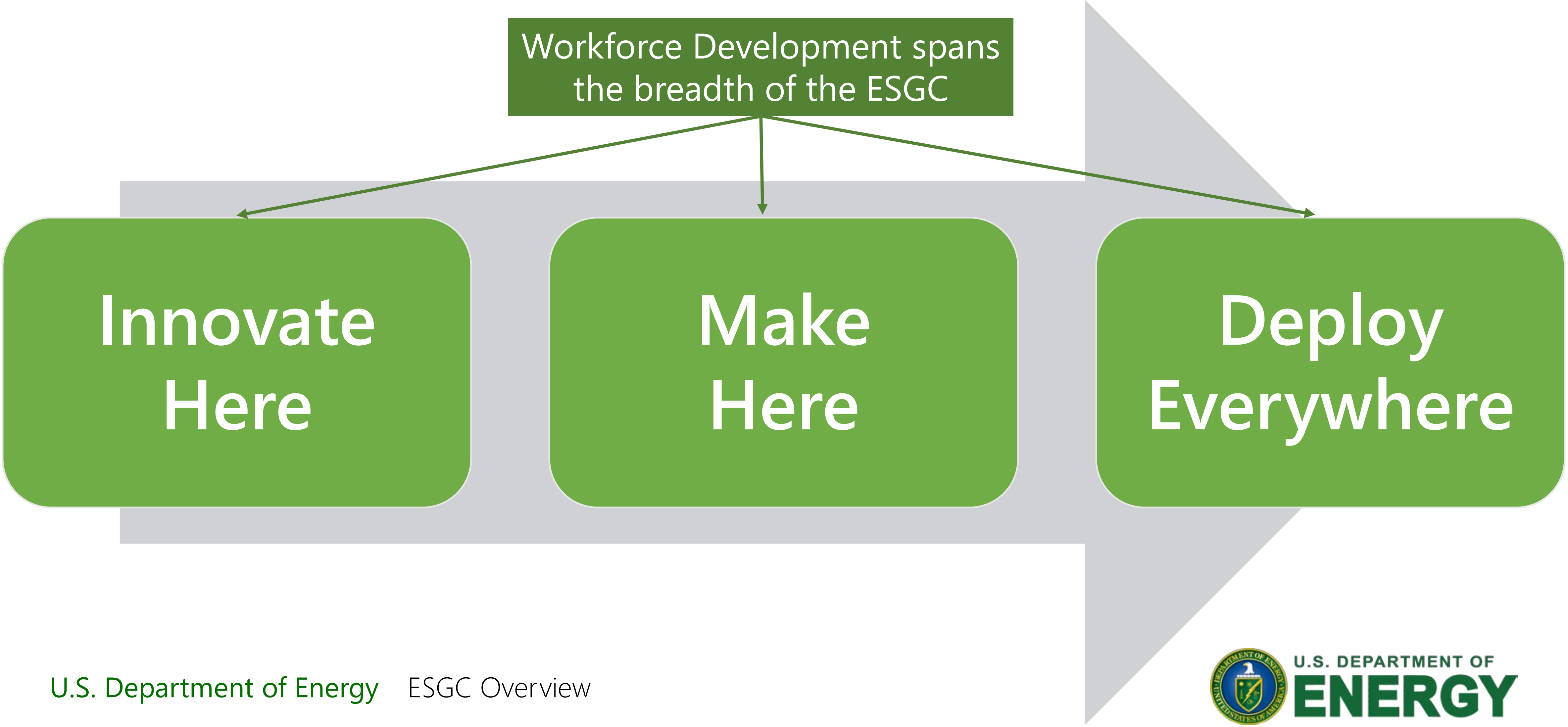
Need:

The lack of trained workers has been identified as a concern for growth of the U.S. industrial base, including many areas of energy storage. A pipeline of people trained in research and development, as well as trades, is needed.

Mission:

For workforce development in energy storage, DOE will support opportunities to develop the broad workforce required for research, development, design, manufacture and operation.

Workforce Development



Workforce Development

DOE currently supports workforce development broadly – from cross-cutting basic research to technology-focused staff

SC's grant and national laboratory research projects support students, graduate students, and postdoctoral fellows:

- BES alone supports over 2,100 (estimated) students each year; large research teams (Hubs, EFRCs) have strong student engagement
- Over 50% of the over 32,000 annual users of the 27 SC User facilities are students and postdocs
- Special SC programs support research and work experiences at the National Laboratories and Early Career research

EERE leverages laboratories and consortia in addition to programs at universities for a variety of education and workforce development programs.

Workforce Initiatives – A Sample

HIGH SCHOOL

National Science Bowl® competitions

UNDERGRAD

Community college internships program

Science undergraduate laboratory internships program

GRADUATE

Graduate student research program

Interdisciplinary and industrially-relevant traineeships

FACULTY

Visiting faculty program for under-represented institutions

Curriculum development for degree programs

WORKFORCE

Lab-embedded entrepreneurship program

Industrial Assessment Centers undergraduate training *(31 universities)*

Community college hands-on training

Energy Storage Internship Program

Workforce Development

Innovate Here:

DOE's ongoing efforts will be leveraged to grow the pipeline of candidates qualified to lead the field in research. This includes supporting innovative research at universities and national laboratories, along with building and operating world-class user facilities.

Image credit: Argonne National Laboratory

Workforce Development

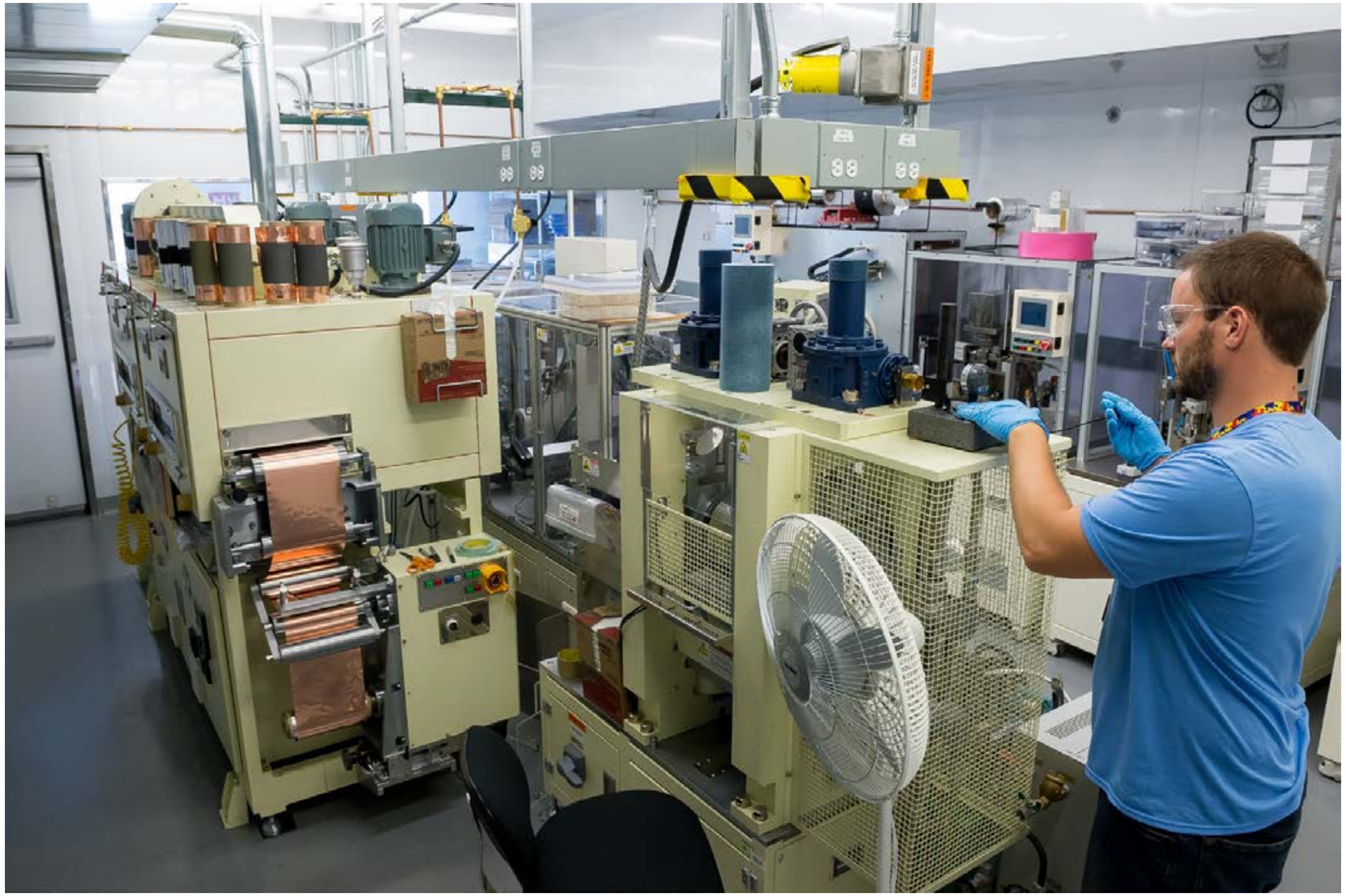


Image credit: Argonne National Laboratory

Build Here:

There is a wide range of potential technology requirements spanning from small to large systems; factory built to bespoke, site-built installations; and chemically to thermally based storage. For the United States to lead in these technologies, there will be a need from trades (machinists, welders, designers), to engineers (mechanical, chemical, electrical) to research scientists (materials science, chemistry).

Workforce Development

Deploy Everywhere:

In order to build, use, and maintain energy storage systems as an integrated part of our country's energy systems, we need a workforce that can understand how these pieces fit together and can be optimized for the particular application. This will require not just technicians, operators and engineers, but analysts who can model and optimize these systems.

Image credit: Bruce Gellerman/WBUR

Activities

Seek detailed stakeholder input on workforce gaps and needs:

- The ESCG will continue to solicit feedback from relevant stakeholders on workforce development issues through ongoing stakeholder engagement across a broad spectrum of energy-storage related industries.

Conduct a needs assessment/skills assessment:

- Conduct a formal study of existing education and workforce development programs in areas of energy storage and the related technologies. This will include activities at all education levels and target audiences.

Enhance opportunities for innovation in workforce development:

- An enhanced focus on energy storage in workforce development activities will broaden awareness of existing programs and encourage cross-communication with the other tracks of the ESGC.

Summary

Strengthen and broaden the relevance of existing programs through increased stakeholder input across the breadth of the ESGC.

Look for opportunities to enhance or develop programs across DOE that will enable the development of the workforce of the future in energy storage at all stages of education and skill sets.

Questions

Please submit your questions in the Chat box to the host and panelists and include the topic or speaker for reference.

Closing Remarks

Michael Pesin

Deputy Assistant Secretary
Office of Electricity

Thank you.

Our next workshops:

- Use Case Overview, May 13
- West/Southwest Regional Workshop, May 19
- Pacific/Northwest Regional Workshop, May 20
- Midwest/Northeast Regional Workshop, May 27

For more information, visit:
https://www.energy.gov/energy-storage-grand-challenge

Appendix

Intellectual Property Rights

U.S. leadership in energy storage requires modern and robust Intellectual Property (IP) and related policies to encourage and sustain domestic storage manufacturing. IP and U.S. manufacturing are tied together.

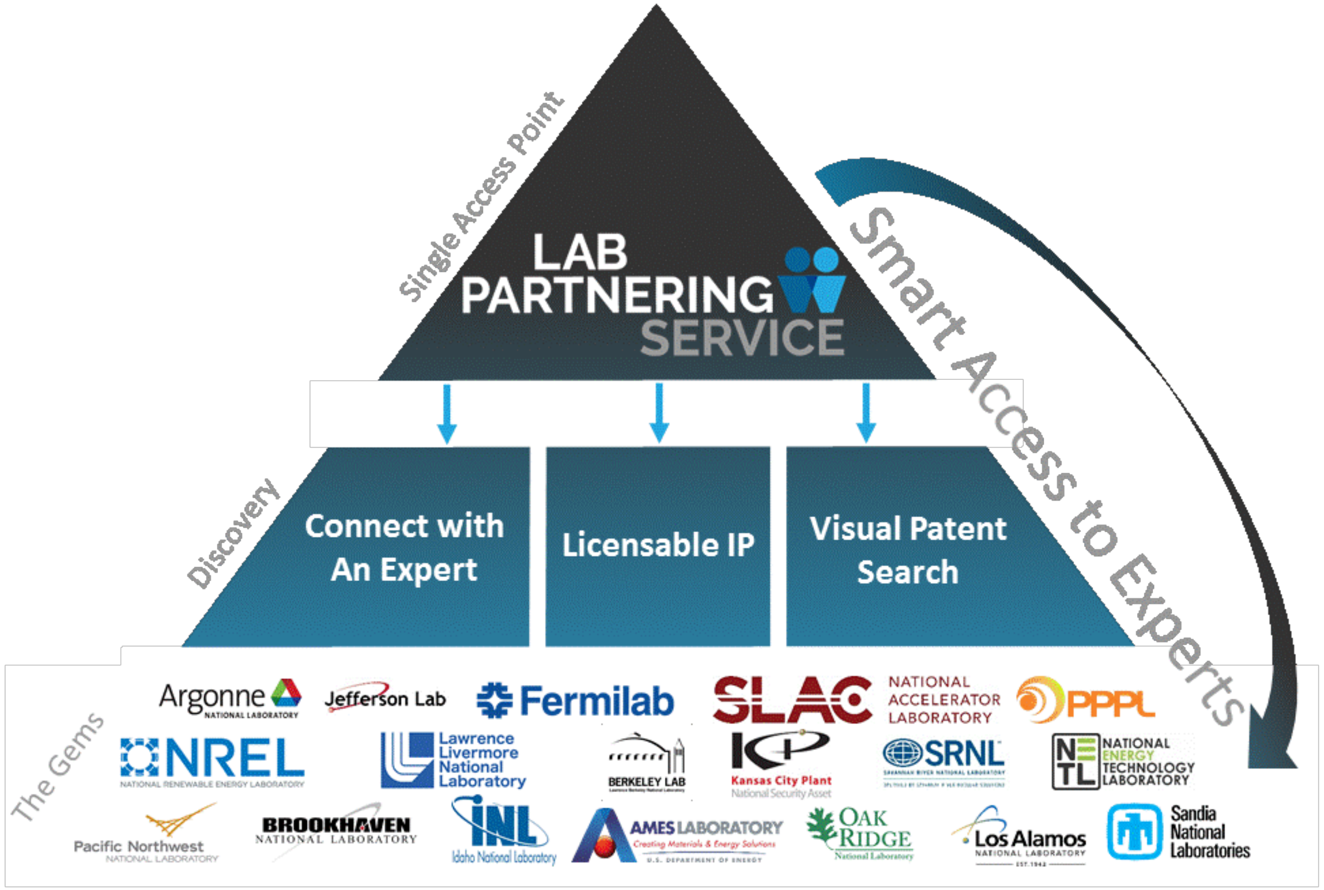
As existing energy storage technologies and manufacturing processes are improved and new ones are developed, this creates new IP. For innovations that originate from public support, DOE currently provides mechanisms for transferring this intellectual property to the private sector, including licensing, cooperative research and development agreements (CRADAs), and work for others.

Under the ESGC, to the extent permissible by law, DOE will require substantial manufacturing in the United States for ten years following award closeout for technologies and processes requiring IP developed through DOE investment. Alternatively, DOE may use IP protection and domestic manufacturing as merit criteria for proposals.

Office of Technology Transitions: Lab Partnering Service

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

Labpartnering.org



Technology Commercialization Fund

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.

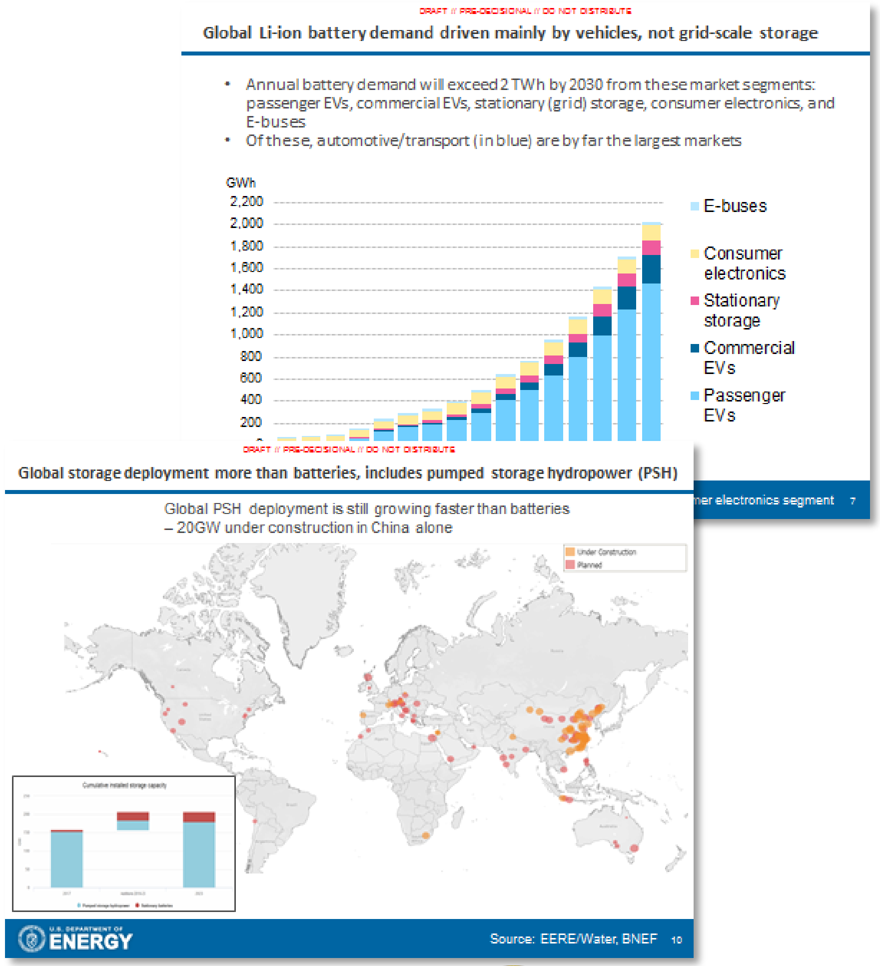
Market Analysis

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

Evaluate fundamental market drivers:

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



Energy Storage Funding Data and Analysis

OTT collects, analyzes, and reports unclassified national lab tech transfer data

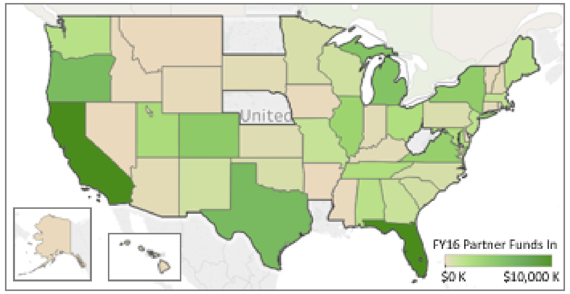
[This comprehensive data set includes sensitive information, but OTT staff are available to support program information requests. Data is available by research taxonomy, partner type, agreement type, partner location, and other parameters.]

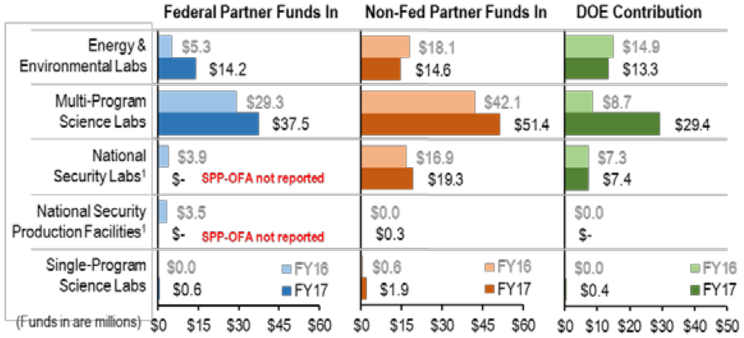
Examples of recent uses:

- 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.

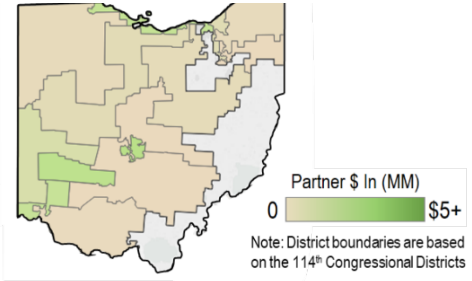
OTT's tech transfer data set is used to provide program specific insights…

National Impact: FY16 Technology Transfer Partner Funding by State for Relevant EERE Agreements





… 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