U.S. DEPARTMENT OF ENERGY

Energy Storage Grand Challenge

Midwest/Northeast Regional Workshop

MAY 27, 2020

U.S. DEPARTMENT OF ENERGY

Welcome and Opening Remarks

Paul Kearns

Director
Argonne National Laboratory

Keynote

Alicia Barton

CEO

New York State Energy Research and Development Authority (NYSERDA)

Energy Storage Innovation In New York

Alicia Barton, President & CEO, NYSERDA
Department of Energy
Energy Storage Grand Challenge Workshop
May 27, 2020

About NYSERDA

Mission

Advance innovative energy solutions in ways that improve New York's economy and environment

Vision

Serve as a catalyst – advancing energy innovation, technology, and investment; transforming New York's economy; and empowering people to choose clean and efficient energy as part of their everyday lives

New York State Clean Energy Goals

now

CLEAN ENERGY ECONOMY
nearly 159,000 clean energy jobs

by 2025

RENEWABLE ENERGY
6,000 MW of distributed solar

RESILIENT and DISTRIBUTED GRID
1,500 MW of energy storage

ENERGY EFFICIENCY
185 TBtu end-use savings
in buildings and industrial facilities

by 2030

RENEWABLE ENERGY/
CLEAN ENERGY STANDARD
70% electricity from renewable energy

GHG REDUCTION
40% reduction in greenhouse
gas emissions from 1990 levels

3,000 MW of energy storage
30,000 employed in storage sector

by 2035

RENEWABLE ENERGY
9,000 MW of offshore wind

by 2040

CARBON-FREE
100% clean electricity

by 2050

GHG REDUCTION
85% reduction in greenhouse
gas emissions from 1990 levels

NYSERDA Storage Incentive Budget and Program Allocation

Program	Total Budget
Bulk (projects > 5 MW)	$150 M
Retail (projects < 5 MW)	$163 M
Long Island	$55 M
Unallocated	$36 M
Total	$405 M

* Chemical, thermal, and mechanical systems are eligible

3,000 MW
of energy storage
by 2030

Up from 1,500 megawatts by 2025

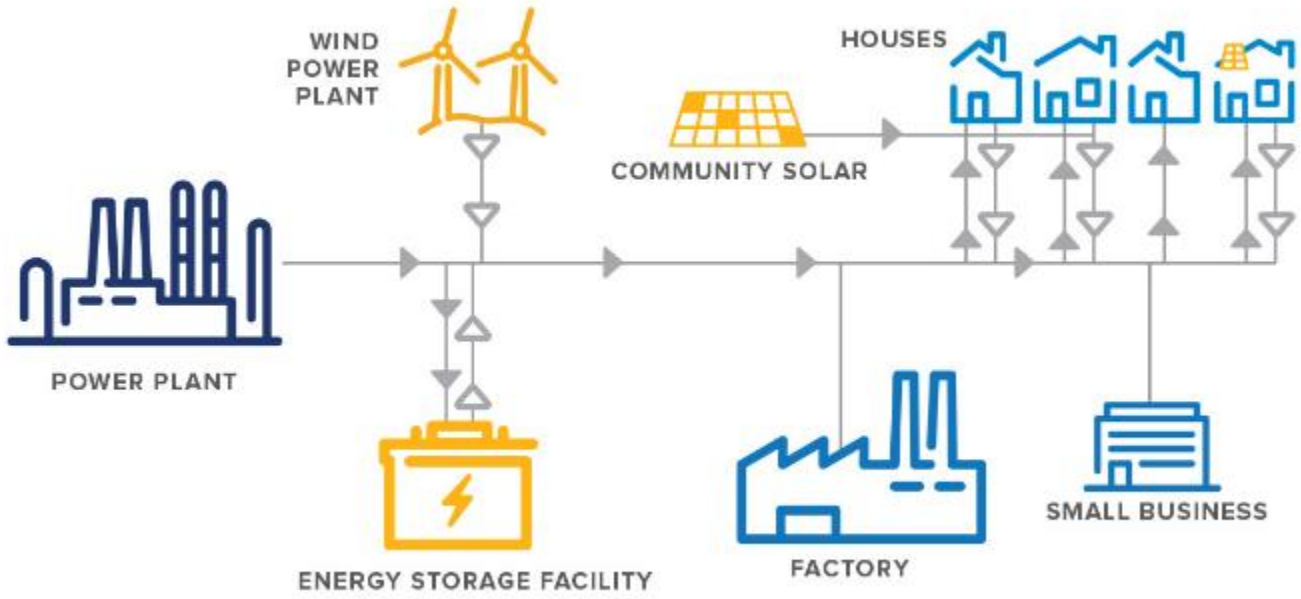
At least 350 MWs being procured by utilities through RFPs

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

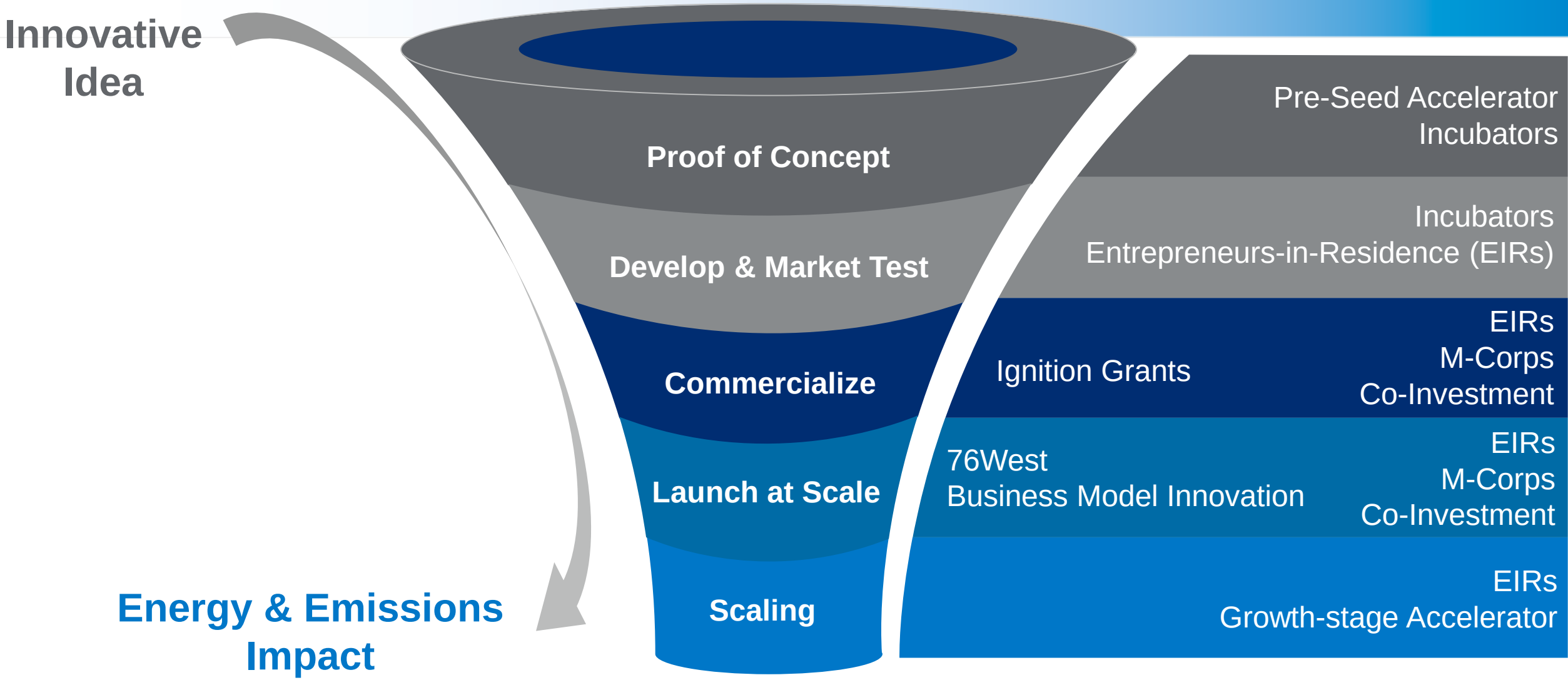
Energy Storage Innovation

Energy Storage and Product Development

Renewable and Distributed Energy Resources Innovation



Technology to Market Programs by Stage



Workforce Development

NYSERDA has modified training programs in response to COVID-19:

> Increased flexibility and funding opportunities for eligible businesses to hire interns and workers.

> Providing special COVID-19 considerations for existing On-the-Job Contractors.

> Offering special incentives for heat pump positions.

> Increased funding caps for businesses of all sizes.

> Reimbursement for longer internships and flexible schedules with increased flexibility for eligibility.

Thank you

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nyserda.ny.gov

Follow NYSERDA

Tech Transitions Overview

Stephen Hendrickson
Program Manager, Office of Technology Transitions
U.S. Department of Energy

Technology Transition

Purpose:

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

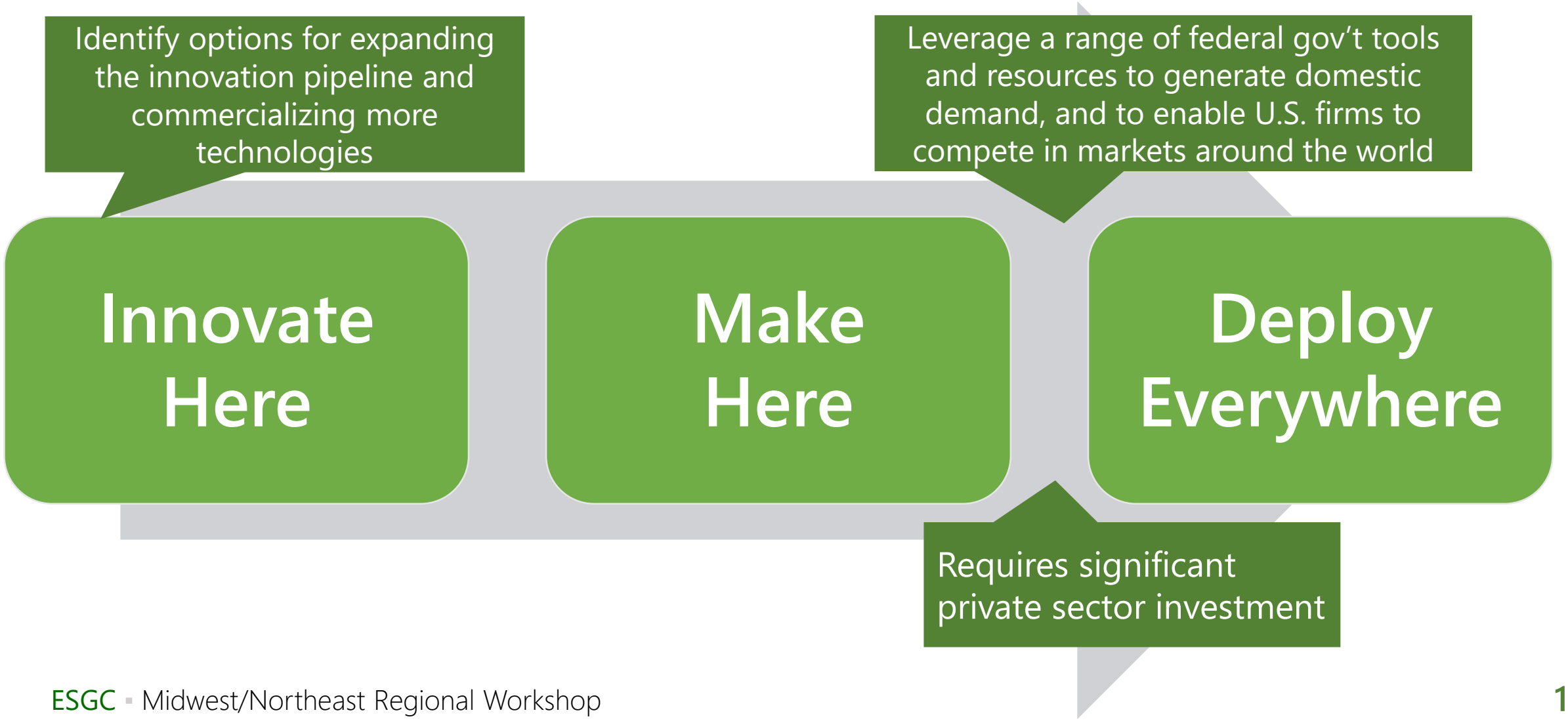
Need:

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



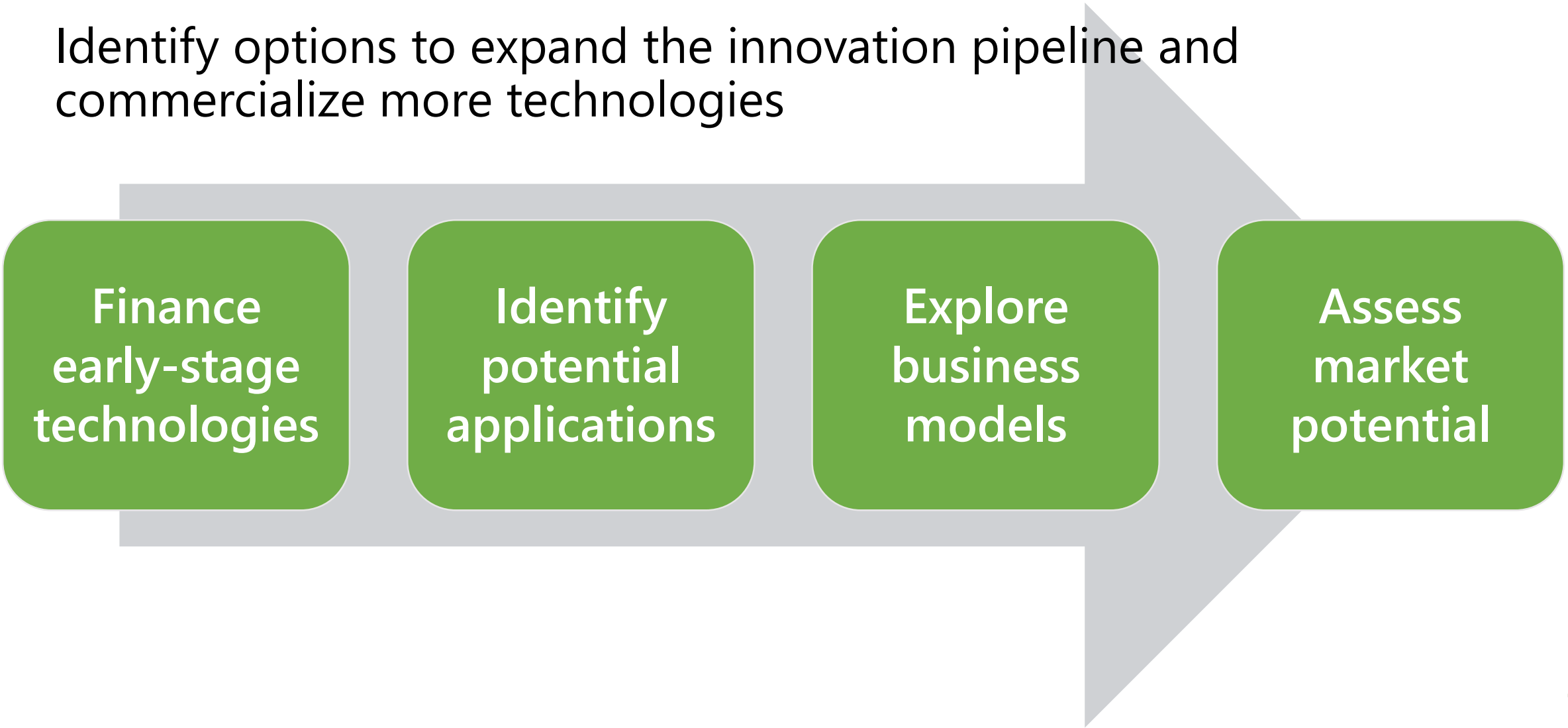
Technology Transition Use Case

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

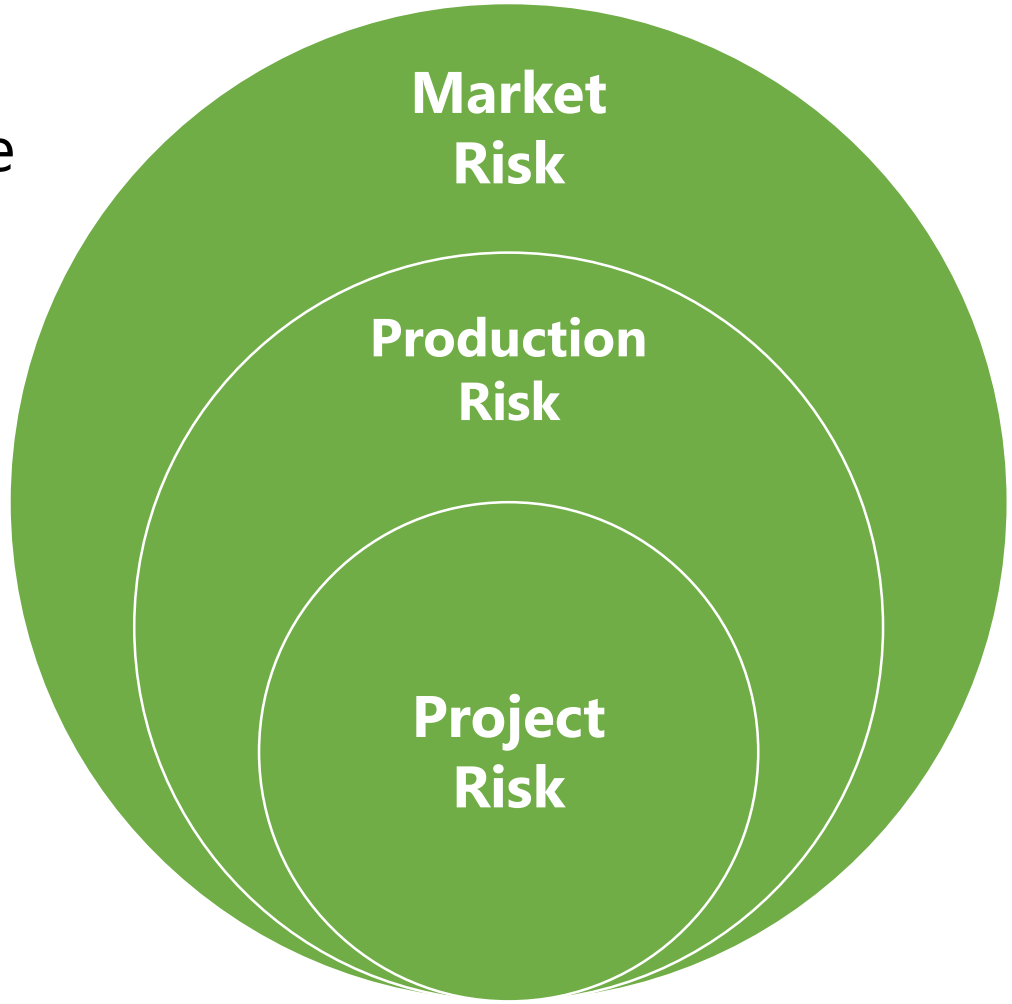
Innovate Here

Identify options to expand the innovation pipeline and commercialize more technologies



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, provide data for validation and standardization, and to evaluate the end-user business case.
7. **Pursue industry collaboration**, innovative financing mechanisms, demonstration projects, and public private partnership opportunities.
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 address these challenges and support U.S. leadership in the global energy storage markets.

ESGC Request for Information

Timeline

- May – Complete RFI and concurrence process
- June – Issue and market RFI
- July 31st – RFI closes
- August 31st – Synthesize RFI responses
- September 30th – Update ESGC Roadmap

Panel 1: 2030 Goals and Vision

Moderator

H.G. Chissell
Founder/CEO,
Advanced Energy Group

Panelists

- John Zhang, City of Chicago
- Suzanna Mora, Exelon
- Kate Tomford, Chicago Transit Authority
- JD Brannock, Invenergy LLC

Panel 1: 2030 Goals and Vision

Moderator

H.G. Chissell

Founder/CEO,
Advanced Energy Group

Without a powerful intention and a daunting obstacle, real drama does not exist.

Aaron Sorkin, Screenwriter
MasterClass

Intention | Obstacle = Drama

In 30 years or less

>>> <<<

Is battery storage

AN ESSENTIAL WARP CORE?

OR

A Mythical Holy Grail?

CITY OF CHICAGO

- Est. population of **2,705,994** (2018)
- **Third largest city** in U.S.
- **International hub:** finance, culture, commerce, industry, education, technology, telecommunications, and transportation.

John Zhang

Chief Engineer,

Electrical & Innovation Technology

Vision & Clean Energy Goals

Challenges: Weather, Large Infrastructure, Reliability, *Economics*

Illinois

100% clean energy by *2050.*

(Illinois Clean Energy Jobs Act)

- **Chicago 2040:** 100% renewable energy
- **Chicago 2035:** Buildings 100% renewable power
- **Chicago Transit Authority 2040:** Fully electric buses

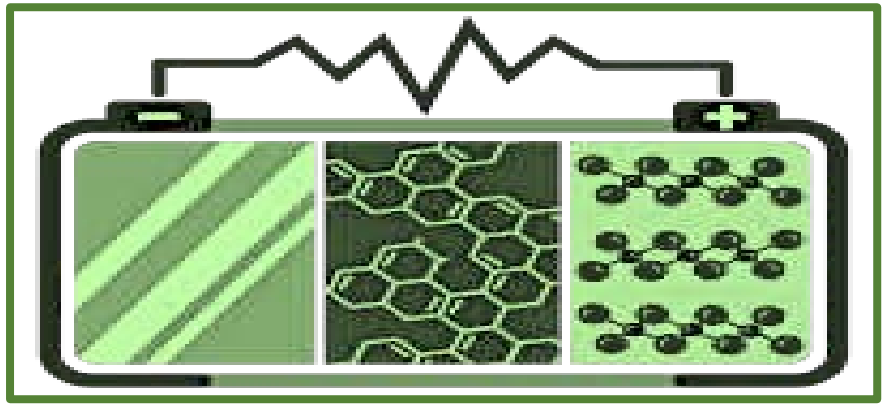
Complicated & Dynamic:

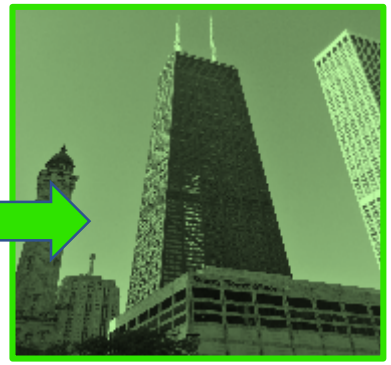
Tools, Trade-offs & Partnerships

Challenge: Energy Storage is enabling tool, but not yet mature & with risks

TOOLS

- **Energy Efficiency**
- **Renewable & Distributed Energy**
- **Energy Storage**





Partnerships

- OSTP **White House**
- **DOE Office of Science**
- **University of Chicago**
- **University of Illinois**
- **National Labs**
- **Industry**
- **Utilities**

Exelon Utilities – Who we are and What Drives Our Evolution

Susan Mora-Schrader

Director, Utility Initiatives

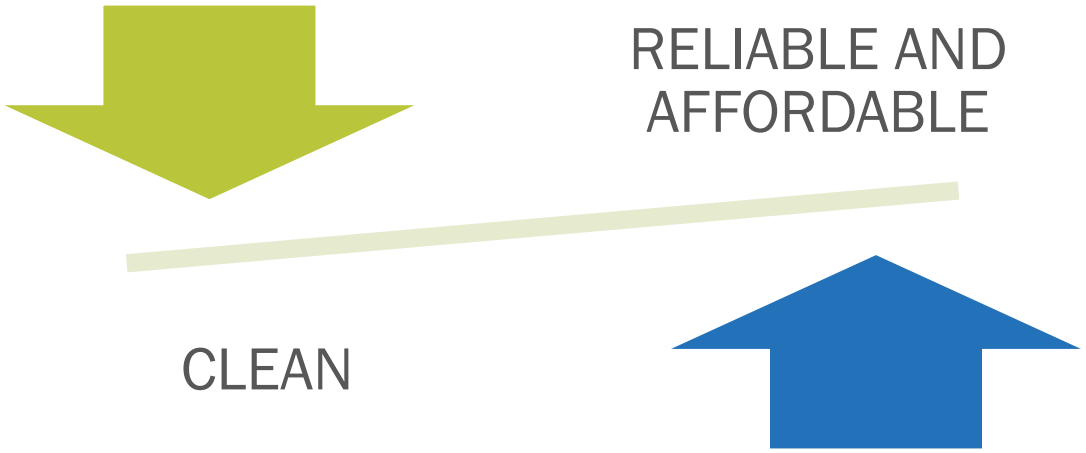
Exelon Jurisdictions:

- **Illinois, New Jersey, Pennsylvania, Delaware, Maryland and the District of Columbia**
- **All restructured markets in which utility ability to own generation is limited**
- **Ambitious carbon reduction, clean energy and ZEV goals:**
  - **100% Clean: DC 2032; Chicago 2035; NJ 2050**
  - **ZEV/LEV states: ZEV -- MD and NJ; LEV – DE and PA**

Exelon.

The Evolving Utility & Balancing Competing Imperatives

YESTERDAY	TODAY	TOMORROW
• SAFE • RELIABLE • AFFORDABLE	• SAFE & SECURE • RELIABLE & RESILIENT • AFFORDABLE • CUSTOMER-FOCUSED • INCREASINGLY CLEAN	• SAFE & SECURE • RELIABLE & RESILIENT • AFFORDABLE & EQUITABLE • CUSTOMER-FOCUSED & INTERACTIVE • CARBON FREE • SERVICE PLATFORM • PLATFORM FOR OTHER INFRASTRUCTURE



DERS increase system complexity and intermittent nature of DERS can affect system reliability. Addressing these DER impacts can negatively impact affordability.

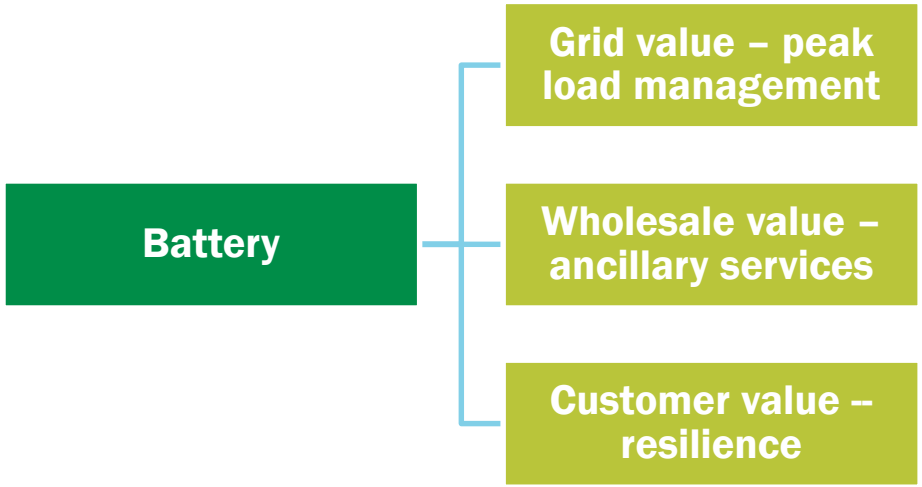
Batteries can increase system reliability BUT are not currently cost-comparable to traditional solutions at the distribution level.

Exelon.

Finding Value, New Business Models & Regulatory Evolution

- Increasing battery value to offset high cost requires tapping multiple value streams.
- Tapping multiple value streams requires new business models.
- Adopting new business models requires new regulatory constructs.

VALUE STREAMS



BUSINESS MODELS

Model	Utility	3rd Party
Utility	Owns, uses as NWA and in wholesale	
Hybrid 1	Owns, uses as NWA	Leases for wholesale
Hybrid 2	Leases for NWA	Owns, uses in wholesale
VPP	Leases for NWA	Aggregates, uses in wholesale

NEW REGULATORY CONSTRUCTS

- Unique asset class for storage
- Utility earns on contracts
- Utility earns on savings

Exelon.

Invenergy: Introduction

An Industry Leader in Developing and Operating Advanced Energy Storage

Speaking: JD Brannock
Manager, Storage Strategy
jbrannock@Invenergy.com

Battery & Inverter Suppliers ▶ System Integrators ▶ **Invenergy** Engineering, Procurement & Construction ▶ Developer-Owner-Operator ▶ PPA or Build-Transfer ▶ Energy Consumer (Utility/Corporate)

900
megawatt hours developed

300
megawatts developed

16
projects developed

5,000+
megawatt hours in development pipeline

Outstanding Industry Achievement Award
Energy Storage Association, 2019

Project of the Year: Grand Ridge
Power Engineering and *Renewable Energy World, 2015*

Innovation Award for Centralized Storage
Energy Storage North America, 2015

Invenergy: Goals & Challenges

Our Foundation
Developing and operating sustainable energy projects around the world

Wind
99 projects
15,034 megawatts

Solar
33 projects
3,560 megawatts

Storage
16 projects
900 megawatt hours
300 megawatts

Natural Gas
11 projects
5,641 megawatts

Energy Storage is an important part of the transformation to a more flexible, reliable, and sustainable grid

Challenges for grid-connected Energy Storage projects

Cost

Today: Economic in *select use cases*
Need ~2x lower cost for *wide adoption*

Potential DOE impact:

Accelerate the *development, design & deployment* of lower cost storage technologies

Rules & Regulations

Markets need to *integrate* and *compensate* storage appropriately

Potential DOE impact:

Need *best practices & standards* for regulators and utilities to incorporate storage in a *fair & consistent* way

Safety & Compliance

Financiers and municipalities *unfamiliar* with storage are wary of the *risks*

Potential DOE impact:

Provide clear *guidance on risks*
Recommend *proven codes/mitigations*

Bus Fleet Electrification at CTA

Goal: Electrify CTA's entire bus fleet by 2040.

Kate Tomford

CTA's Bus System:

- **1,860+ buses** in the fleet
- **1,000+** buses due for replacement in the **next 5 years**
- 24/7 bus service
- 127 bus routes
- 7 garages (storage & maintenance)
- Service blocks up to **300 miles**

CTA New Flyer Electric Bus

Bus Fleet Electrification at CTA

e-bus program - past, present, and future: increasing power demands

2014 - 2019

- 2 New Flyer e-buses
- 300 kWh batteries
- **Garage** charging: **100 kW**

2020

- Retrofitted New Flyers
- 6 Proterra e-buses
- 440 kWh batteries
- **On-route** charging: **450 kW**

2021 – 2040+

- 17 more Proterras
- Garage electrification
- 800+ MWh batteries
- **10-15 MW** load at each **garage**

Bus Fleet Electrification at CTA

CTA's e-bus challenges and recommendations

Challenges	Battery-Related Recommendations
$744M = Incremental cost of e-buses: (~$400K/bus x 1,860 buses)	• ***Reduce battery cost*** • ***Increase battery lifetime / resilience to cycling***
Cost of charging infrastructure	• Utilize CTA's existing traction power infrastructure?
Cost of garage upgrades + new garage	• Develop energy storage for redundancy / resilience
Operational complexity of charging	• ***Standardize charging equipment & protocols*** (interoperability of sub-fleets is critical) • Design automated charge management & optimization
Battery second life	• ***Need cost-effective second life use or recycling***

Questions

Please submit your questions in the Chat box to the host. Reference the speaker or topic.

Panel 2: Economic Voice of the Customer

Moderator

H.G. Chissell
Founder/CEO,
Advanced Energy Group

Panelists

- Craig Rigby, Clarios
- Yet Ming Chiang, MIT
- Colin Wessells, Natron Energy
- Sara Chamberlain, Energy Foundry

CLARIOS

Powering today, into tomorrow

Clarios

- Previously known as Johnson Controls Power Solutions
- Acquired by Brookfield Business Partners May 2019
- Leading global manufacturer of automotive batteries
  - Leader in low-voltage lead-acid and lithium-ion technology
  - Producing 150+ million batteries produced annually
  - Serving 150+ countries with sales and distribution
  - 50+ manufacturing, distribution and recycling facilities globally
  - Established largest circular economy for batteries

Craig Rigby

Vice President – Technology, Clarios

- 20+ years in automotive electrification
- 13 years at Clarios leading engineering and technology development
- Recognized thought leader on battery technology development and adoption in automotive applications

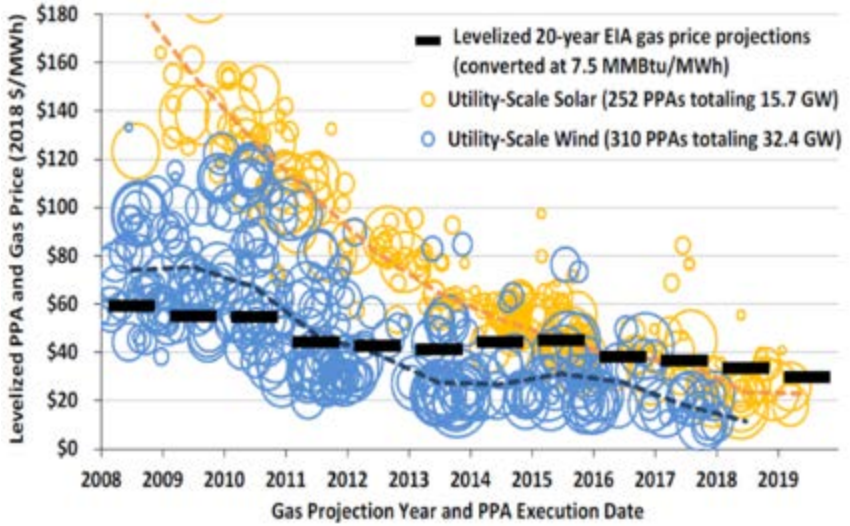
Managing Economic Risk:
The key to mass introduction of new energy storage technologies

- Scale of investment for mass production relative to R&D is order(s) of magnitude greater
- Demand for new technologies must be clear and value proposition understood prior to investment
- Manufacturing and Supply Chain will follow credible demand when sufficient scale is achieved
- Materials availability at scale is necessary but closed-loop lifecycle will make that sustainable

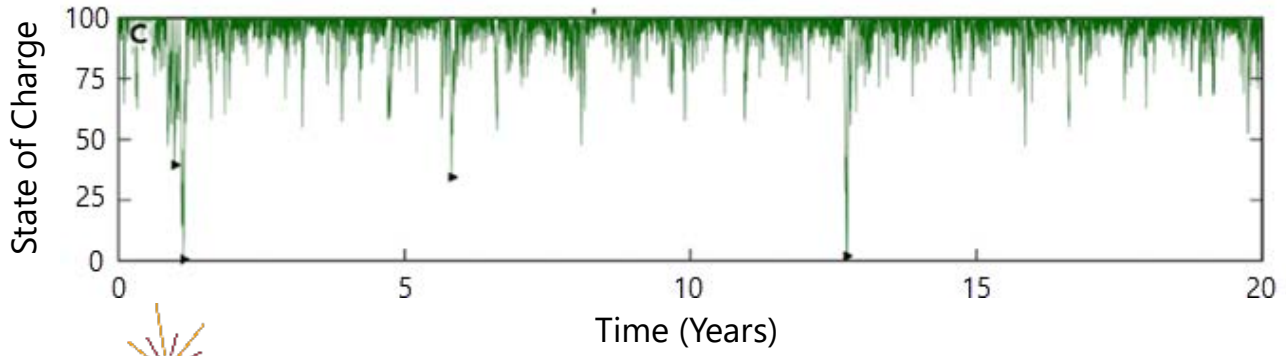
Yet-Ming Chiang, MIT

Multi-day storage will be needed to make renewable electricity fully dispatchable

Levelized cost of electricity from solar, wind and natural gas



Renewable dispatchable power requires many multi-day discharges over 20 year system life (Example here: Iowa wind + solar)



"Energy Storage requirements for shaping renewable energy toward grid decarbonation," M. S. Ziegler, *et al.*, *Joule*, https://doi.org/10.1016/j.joule.2019.06.012

To be competitive with natural gas:

- $1000/kW = 100h x $10/kWh
- Grid Li-ion today: $250/kWh

How much storage will we need?

- ~100 TWh for full decarbonization worldwide (electricity + vehicles)
- Li-ion can't do it all, would require:
  - 3x lower cost than minerals alone
  - 10% CAGR in production of key elements (Li, Ni) now through 2050
- Getting to 100 TWh at $10/kWh requires ultra-abundant, low cost chemistry based on sulfur, zinc, iron

form energy

JCESR | Joint Center for Energy Storage Research

THE ENGINE

Breakthrough Energy

eni

What Can Government Do to Help?

1. Support the development of open-source modeling capabilities that can identify where and how storage should be applied to generate the most value
2. Support manufacturing R&D, from basic research to pilot manufacturing of the components for large-scale storage in existing scaled industries
3. Support technical pilots and initial commercial demonstrations. Finance real-world demonstrations necessary to achieve bankability and secure future project finance.

Natron Energy

DOE ESGC Webinar

Colin Wessells, CEO

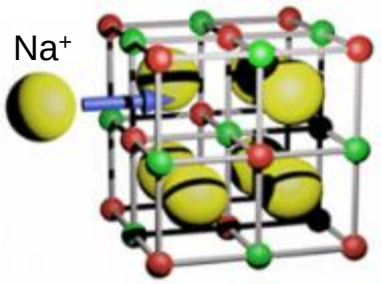
May 27, 2020

Introduction to Natron Energy

- Company history
  - Stanford spin-out, founded in 2012.
  - First funded by ARPA-E with VC cost share – we exist because of ARPA-E.
  - 4 private funding rounds in past 7 years.
  - About 50 employees as of Q2 2020.

- Technology
  - New chemistry: Na^+ electrolyte, Prussian blue electrodes.
  - Safe, high power, long life: no thermal runaway, ±60C rate, 50-100k cycles.
  - Trade off: low energy density, comparable to lead acid.

- Fully de-risked product for sale today: TRL9+
  - Once-a-decade event for a new cell chemistry.
  - Industrial power products for data centers, EV charging, etc.
  - We are focused on manufacturing scale up.



Server rack containing Natron batteries

Natron BlueTray4000

Natron Enables the Next Generation of Industrial Power

- Markets
  - Data centers: >3% of global electrical load, $7B/year batteries.
  - EV fast charge support: future $2-5B/year market.
  - ESGC use cases: Network Infrastructure, Electrified Mobility, Resilience & Recovery.

- Our goal: global-scale impact.
  - Domestic production and sales began in 2019.
  - We will build and sell anywhere.

- Financing strategy: impact and strategic investors
  - Impact VC: energy, clean tech, or materials.
  - Strategics: customers, integrators, or suppliers.
  - $66M invested / $7.6M federal/state awards.
  - Challenge: $180-200M required for profitable green-field manufacturing.

Fund Product/Plant Partnerships to Achieve U.S. Competitiveness

- Valley of death in public and private funding: $20-50M for first manufacturing.
  - Existing funding sources focus on early stage R&D or high volume growth.
  - In between lies a systemic gap in funding for first manufacturing and sales: the valley of death.

- Untapped opportunities to leverage existing domestic manufacturing:
  - Idle Li-ion plants (ex-ARRA) should be repurposed for new products.
  - Idle fine chemicals / pharma plants should be repurposed for battery materials.
  - Problem: most idle plants are troubled businesses unwilling to take risks for new products.

- To achieve competitive domestic production of new batteries:
  - Systematically fund partnerships between existing plants and new products.
    - $20-50M award with <6 months lead time, proposal to disbursement.
  - Or, build a network of public foundries.
    - Buy and operate existing plants for ventures that agree to keep future production in the US.
    - Production output 1000x bigger than DOE user facilities – truly de-risk future plants.

Energy Foundry is a venture capital fund that invests in early stage energy and cleantech startups

ENERGY FOUNDRY

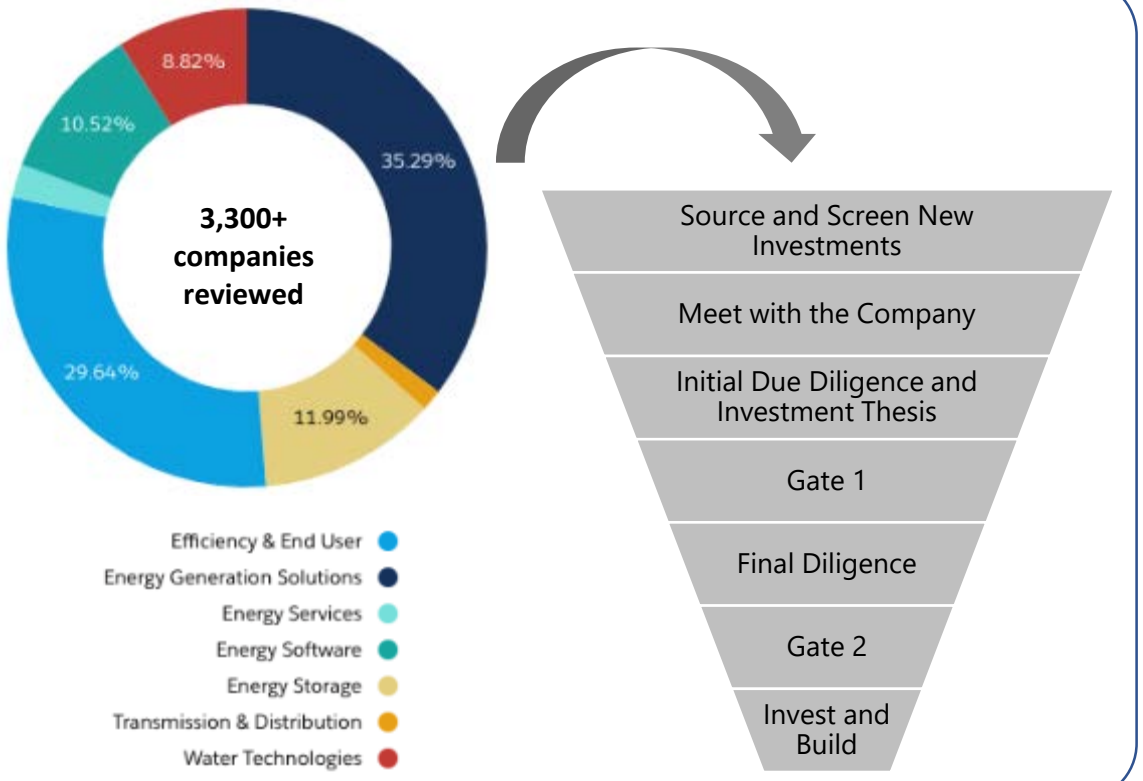
Sara Chamberlain
Co-Founder &
Managing Director

We look for…

- ☑ **Unique business models** and/or technology with **defendable IP**
- ☑ The potential to **disrupt** large and/or commoditized sub-markets
- ☑ **Capital-efficient** business models (i.e. licensing, work with OEMs, etc.)
- ☑ Solutions for **well-defined customer pain-points**, indicating excellent product-market-fit
- ☑ **Early success engaging strategic partners** for pilots and business development
- ☑ **Scalable** products and business models

Sara Chamberlain –
Managing Director, Energy Foundry

Energy storage technologies account for about ~12% of our dealflow, and we've made 3 investment in the sector



What can help stimulate venture investment in energy storage technology?

1. Non-dilutive funding, programs and resources to support scale-up and commercial demonstration
2. Technology with the potential to be 'drop in' with existing customer manufacturing processes / supply chain
3. Success stories and examples of business expansion

Questions

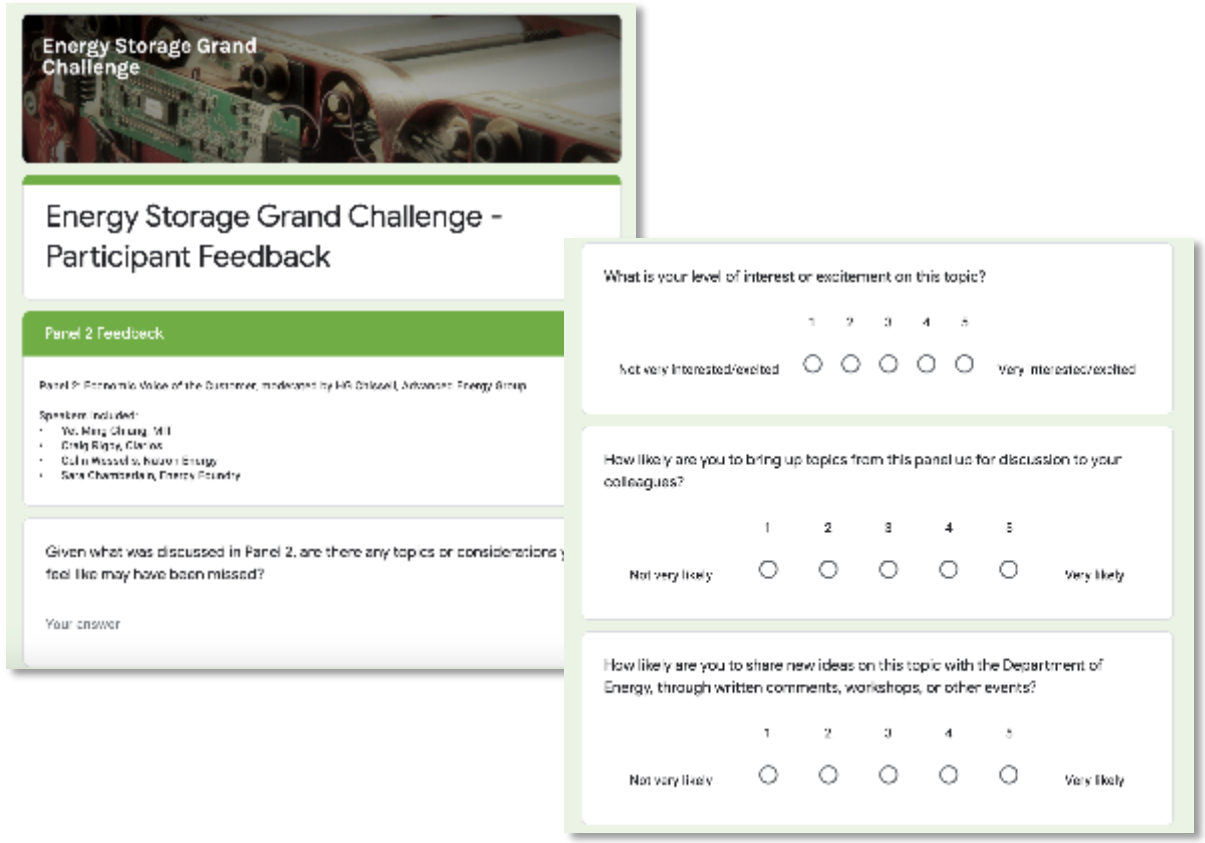
Please submit your questions in the Chat box to the host. Reference the speaker or topic.

Workshop Feedback Form

After this workshop, we invite you to share your additional thoughts and comments about the presentations you heard today. This may include additional questions, concerns, considerations, or suggestions for the Department of Energy.

This is an opportunity to provide us with feedback on how interesting and relevant the material from the panels were. You are also able to opt-in to be involved in future Department of Energy events.

The link is available through the chat function in WebEx.



Wrap Up

Sue Babinec

Program Lead – Stationary Storage
Argonne National Laboratory

Wrap Up

Thank you.

For more information or to access recordings of other ESGC workshops, visit:

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

U.S. DEPARTMENT OF ENERGY