Regulatory Research and Technical Assistance

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OE Energy Storage Program Peer Review
Presentation 203

U.S. DEPARTMENT OF ENERGY BATTELLE

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Agenda

- **Equitable Regulatory Environment: Thrust Area Overview**
- **2021 Highlights**
  - Journal Article: “Emerging Best Practices for Modeling Energy Storage in Integrated Resource Plans”
  - Joint Report: “Energy Storage for a Modern Electric Grid: Technology Trends and State Policy Options”
  - State and Industry Engagements
- **Looking Ahead**

Equitable Regulatory Environment Mission

Mission Statement

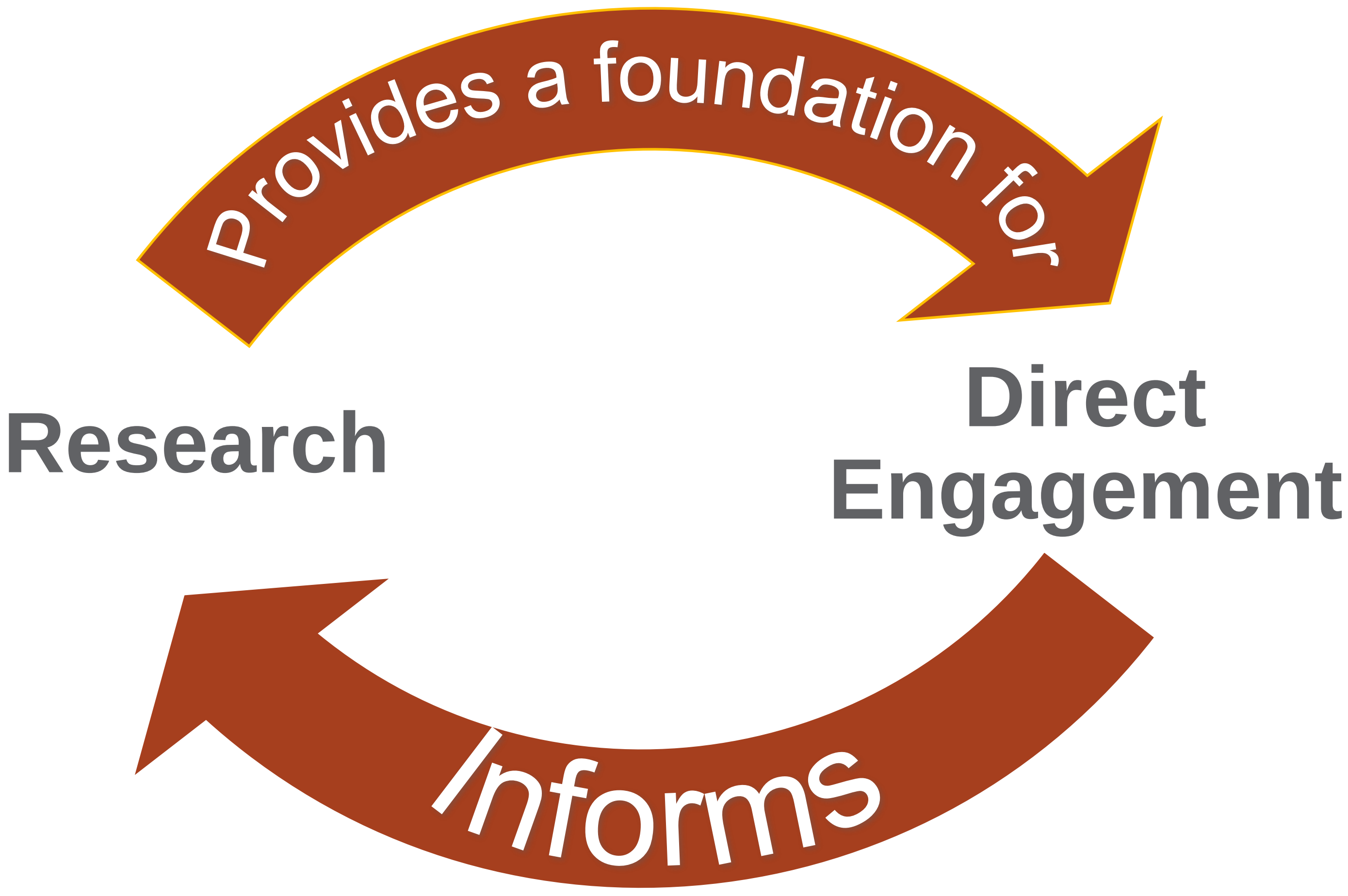
"Value propositions for grid storage depend on reducing institutional and regulatory hurdles to levels comparable with those of other grid resources."

Program Tasks:

- **Document** federal, state and local policies affecting storage deployment
- **Review** integrated resource plans (IRPs) and similar analytic processes affecting storage development and deployment
- **Explore** alternative policies that may affect technology attributes and deployment
- **Maintain** publicly available information on storage technology and attributes affecting its deployment
- **Disseminate** comprehensive information on storage technology status, experience, and realizable contributions to grid resilience, emergency response, renewable deployment, and asset utilization
- **Provide** best practices for installation and use of energy storage to regulators, policy makers and industry

Program Model

- Policy options and impacts
- Planning obstacles and best practices
- Emerging use cases (i.e. resilience, transmission, energy system equity)
- Discrete issues (ownership models, PURPA, hybrid resources, etc.)



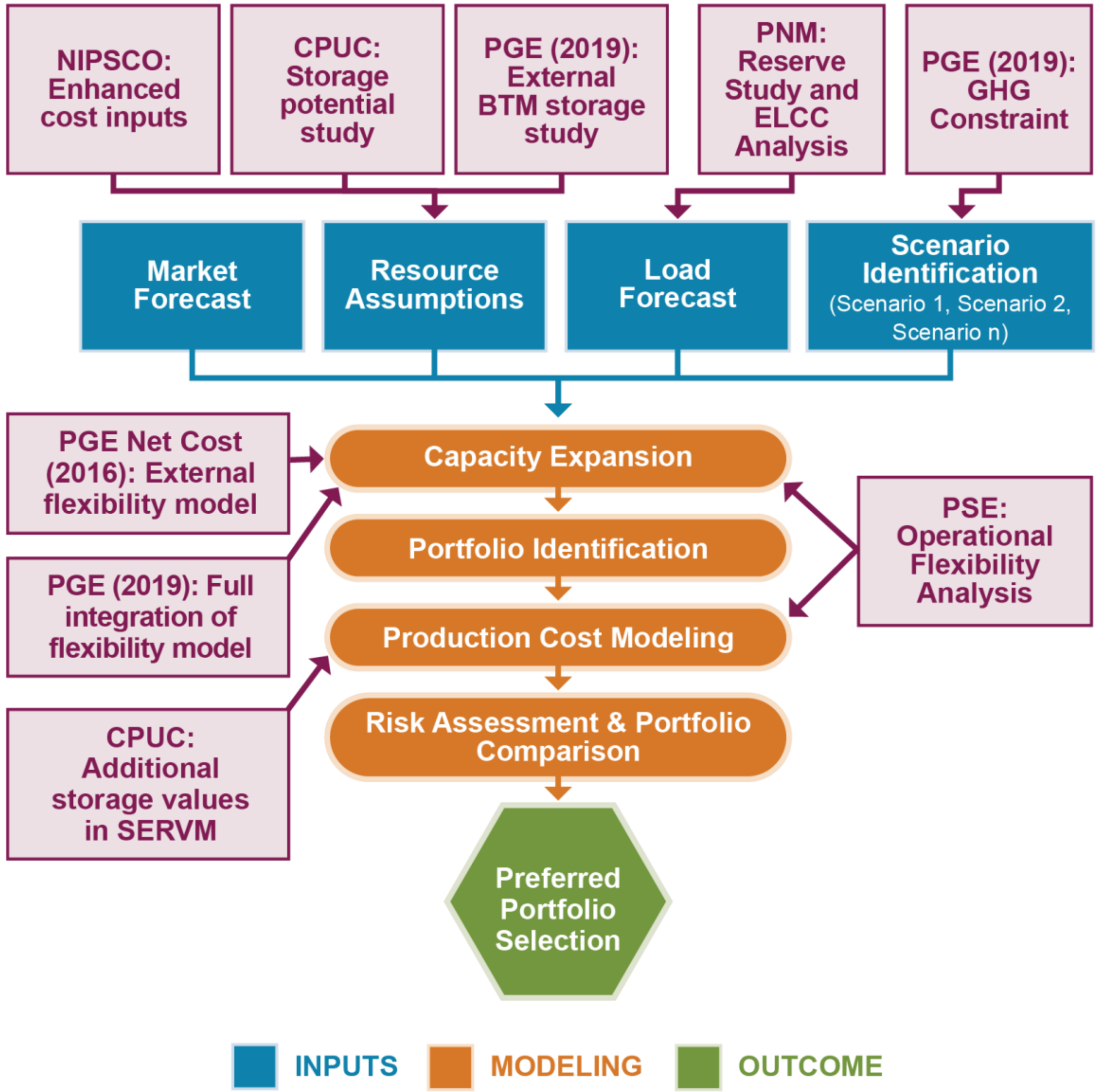
- Technical Workshops
- Conference Presentations
- Regulatory filing review
- Valuation
- Interconnection standards
- Codes and safety tutorials

Journal Article:
Emerging Best Practices for Modeling Energy Storage in IRPs

Traditional modeling tools used in integrated resources plans (IRPs) are not designed to capture the flexible and locational benefits of energy storage. In this publication, we review how leading utilities are evolving their processes to overcome those barriers.

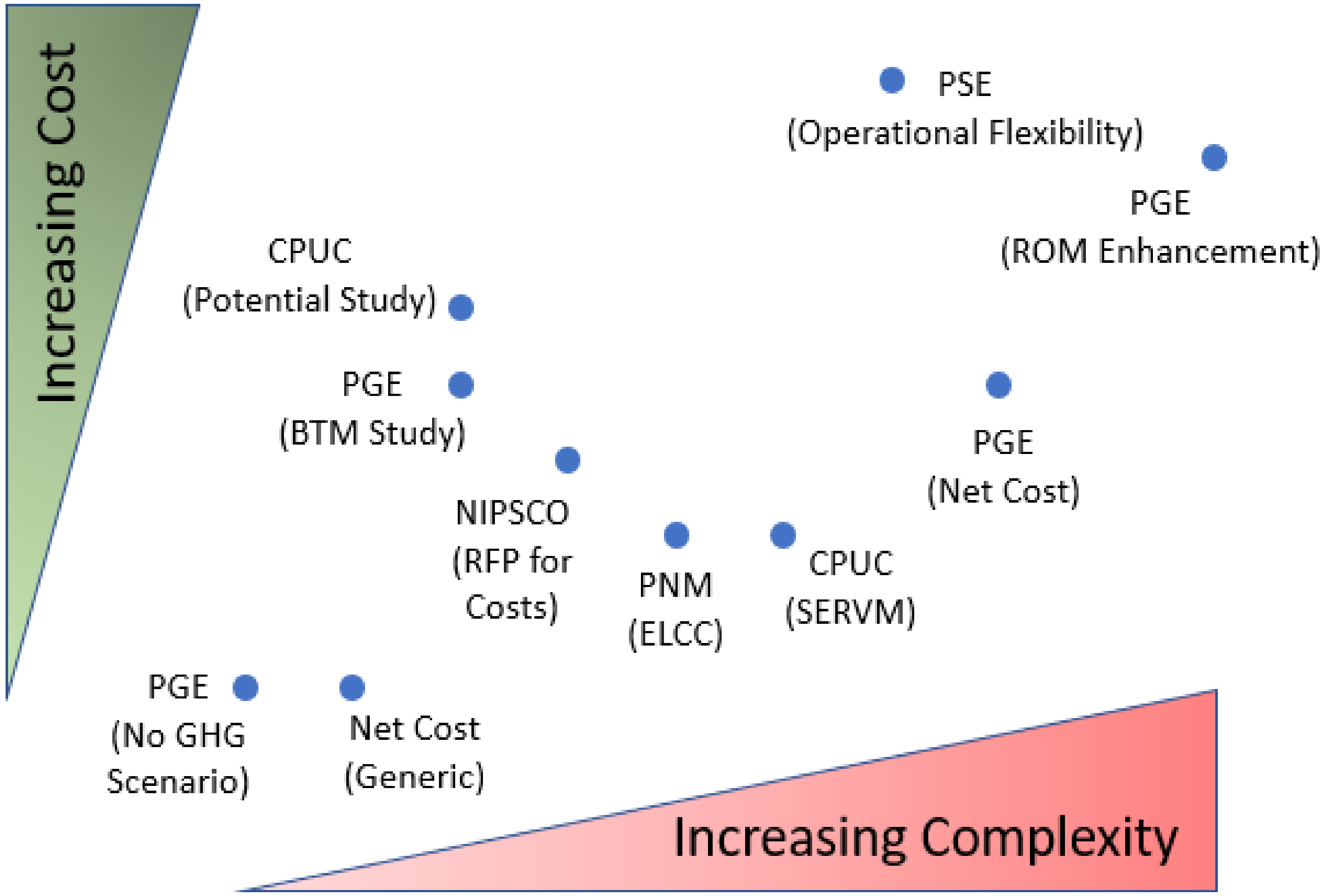
Key findings:

- The complex IRP process creates multiple points of entry for improving storage modeling
- Some practices relate to model inputs (cost & performance assumptions, need forecast, scenario identification)
- Others relate to the modeling process (in-house model development, commercial model licensing, flexibility valuation at various points in the process)
- IRP transparency is crucial to regulatory proceedings, but utilities differ widely in how transparently they describe their assumptions and modeling approaches



Journal Article:
Emerging Best Practices for Modeling Energy Storage in IRPs

We identified nine distinct practices that vary widely in both cost and complexity. By illustrating these relationships, we can assist utilities in identifying access points and evolutionary pathways.



This article has been accepted for publication in a special edition of *IEEE Electrification Magazine* on energy storage that will be published in December 2021.

Joint Report:

Energy Storage for a Modern Electric Grid: Technology Trends and State Policy Options

Pacific Northwest NATIONAL LABORATORY

PNNL assisted the National Conference of State Legislatures in preparing a primer on energy storage for its membership.

- Overview of how the electric grid works and how storage can support it
- Summary of different energy storage technologies and their key characteristics
- Barriers to energy storage deployment and overview of legislative actions taken to address those barriers
- Case studies illustrating real-world benefits of energy storage

	Description	Key Characteristics	Applications	Response Time	Limitations
ELECTROCHEMICAL	**Lithium Ion Batteries** Small cells aggregated in to projects of various sizes	• Duration: 30 minutes - 4 hours • Cycle life: 3,500 • Round-trip efficiency: 85% • Highly flexible	• Capacity • Ancillary Services • Customer	Fast	Flammability, recyclability
ELECTROCHEMICAL	**Flow Batteries** Negatively and positively charged electrolytes are circulated around a membrane to generate an electric current	• Duration: 4-8 hours • Cycle life: 10,000 • Round-trip efficiency: 70% • Highly flexible	• Capacity • Ancillary Services • Customer	Fast	Limited experience, mechanical challenges
ELECTROCHEMICAL	**Sodium Batteries** Use molton or solid sodium technology	• Duration: 15 minutes • Cycle life: 200,000 • Round-trip efficiency: 85% • Highly flexible	• Capacity • Ancillary Services	Fast	High operating temperature
ELECTROCHEMICAL	**Power to Gas** An electrolyzer uses an electric current to separate the hydrogen from water and capture it as a fuel that can be used in a fuel cell or burned for electric generation. Because electrolyzers can be turned on or off on demand, they can be flexible grid assets.	• Duration: N/A • Cycle life: N/A • Round-trip efficiency: 35% (National Renewable Energy Laboratory) • Highly flexible (elecyrolyzer) • Moderately flexible (hydrogen fuel)	Electrolyzer: • Demand response • Frequency regulation Hydrogen Fuel: • Capacity • Spin/non-spin reserve	Moderate to fast	Lack of delivery infrastructure for hydrogen, very low round-trip efficiency
THERMAL	**Ice Thermal Storage Electricity** Used to freeze water, which can later be used to offset air condtioning needs	• Duration: 4 - 6 hours • Can shift up to 95% of HVAC loads to off-peak times	• Demand Response	N/A	Does not return electricity to the grid
THERMAL	**Concentrating Solar Mirrors** Directs sunlight at at tour or pipe where a molten salt traps the heat and used it to power a turbine	• Duration: 6 - 12 hours • Round-trip efficiency: 85% • Moderate flexibility	• Capacity • Spinning/ non-spinning reserve	Moderate	Geographic constraints
MECHANICAL	**Pumped Storage Hydro** Water is pumped uphill and stored, then released to run back down and power a turbine	• Duration: 8+ hours • Cycle life: 15,000 • Round-trip efficiency: 80% • Limited flexibility	• Capacity • Spinning/ non-spinning reserve	Slow-responding Next-generation technologies may achieve moderate response	Geographic constraints
MECHANICAL	**Compressed Air** Air is compressed in enclosed space, then the pressurized air is released as need to power a turbine	• Duration: 8+ hours • Cycle life: 10,000 • Round-trip efficiency: 50% • Limited flexibility	• Capacity • Spinning/ non-spinning reserve	Slow to moderate	Geographic constraints
MECHANICAL	**Flywheels** Energy is stored by spinning a large rotating flywheel/cylinder, a generator attached to the cylinder can convert the rotational energy to electricity as needed	• Duration: 15 minutes • Cycle life: 200,000 • Round-trip efficiency: 85% • Highly flexible	• Frequency regulation • Frequency response	Fast	Short duration

State and Industry Engagements

Midwestern states (with Lawrence Berkeley National Laboratory)

- Assisted in a Grid Modernization Lab Consortium workshop on energy system planning, discussing the role of energy storage in IRPs and distribution system planning

National Association of State Utility Consumer Advocates (with LBNL)

- Assisted in a Grid Modernization Lab Consortium workshop on energy system planning, discussing the role of energy storage in IRPs and distribution system planning

Colorado

- Supported the State Energy Office in drafting an RFP for a study evaluating the potential for energy storage to support DC fast charging in remote locations; providing ongoing advisory support

New Jersey (with Sandia National Laboratories)

- Assisted in a series of workshops covering multiple storage topics (PNNL contributions included federal policy overview, overview of local distribution company operations, and storage as transmission)

Washington

- Assisted staff at the Washington Utilities and Transportation Commission in reviewing utility assumptions and modeling of energy storage in their IRP filings

State and Industry Engagements

South Carolina (with LBNL)

- Presented on the role of energy storage in IRPs for the South Carolina Public Service Commission

Western states (with LBNL and the Western Interstate Energy Board)

- Assisted in a Grid Modernization Lab Consortium workshop on energy system planning, discussing the role of energy storage in IRPs and distribution system planning

Michigan

- Supported the Michigan Public Service Commission’s MI Power Grid Initiative with presentations to two working group sessions, one on energy storage ownership models and one on storage as a transmission
- Presented to the Michigan Climate Advisory Committee on potential roles for energy storage in supporting the state’s decarbonization and equity goals

Wisconsin (with SNL)

- Presented on energy storage as a transmission asset at a Wisconsin PSC workshop

Massachusetts (town of Medway)

- Provided an overview of energy storage technologies and codes and safety standards to town planning officials considering a request for a large energy storage installation to be sited in their town

State and Industry Engagements

Energy Storage Association

- Presented on the role of energy storage in utility integrated resource plans at the ESA's Planning for Storage workshop in December 2020
- Presented an Energy Storage 101 seminar at the ESA's virtual conference & expo in April 2021

Colombia

- Working with the U.S. Energy Association, recorded two training sessions for Colombian regulators on energy storage policy options and planning processes

CAPER

- Presented on best practices for modeling storage in IRPs at a conference of the Center for Advanced Power Engineering Research, a research partnership between academia and the utility industry

Department of Energy

- Presented on best practices for modeling energy storage in IRPs to the Energy Storage Grand Challenge's national laboratory community of practice
- Assisted DOE in drafting response comments to FERC's advanced notice of proposes rulemaking on transmission planning

Looking Ahead: Ongoing and Planned Projects

Reports

- Retrofitting PV with energy storage
- Quantitative analysis of the California energy storage mandate
- Overview of energy storage safety codes & standards for regulators and policymakers
- Vehicle to grid applications
- Best practices in interconnection queue reform
- Deploying energy storage in a co-op setting
- Principles of energy equity program design

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Thank you

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