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NATIONAL LABORATORY

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Assessing the Economic Benefits of Washington Clean Energy Fund Storage Projects

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Washington Clean Energy Fund (CEF) Project Synopsis

Objective

Provide a framework for evaluating the technical and financial benefits of energy storage, and exploring the value that energy storage can deliver to Washington utilities and the customers they serve.



Phases

Phase 1:
Data and Data
Systems

*Phase 2: Use Cases /
Performance
Monitoring*

Phase 3:
Evaluation

- 1) Develop Data Requirements and Data Systems
- 2) Install Energy Storage Systems (ESS), Run Use Cases, and Document Technical Performance
- 3) Evaluate Technical and Financial Performance



Department of Commerce
Innovation is in our nature.



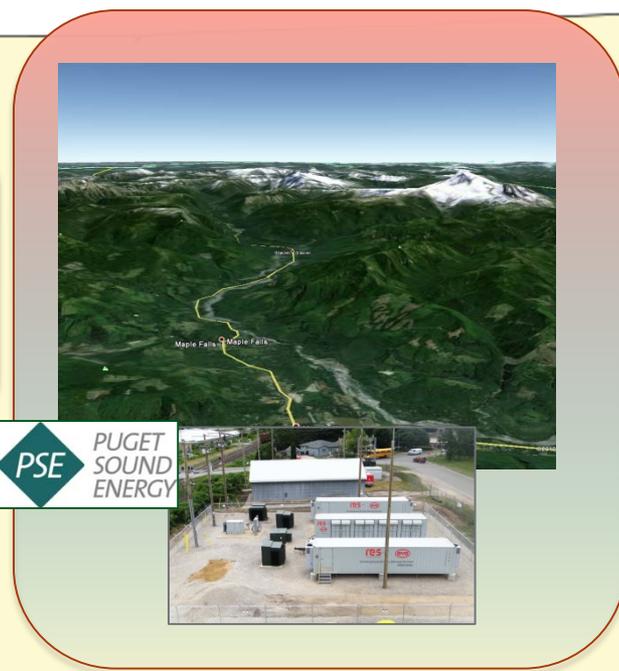
Team

- ▶ **PNNL:** Brings expertise in energy/economics/environment system analysis and modeling
- ▶ **PSE, SnoPUD, and Avista:** Bring deep operational experience and required utility data / test sites
- ▶ **Washington Dept. of Commerce:** Program management





Washington State Clean Energy Fund Energy Storage Projects



Avista
1 MW / 3.2 MWh vanadium-flow battery

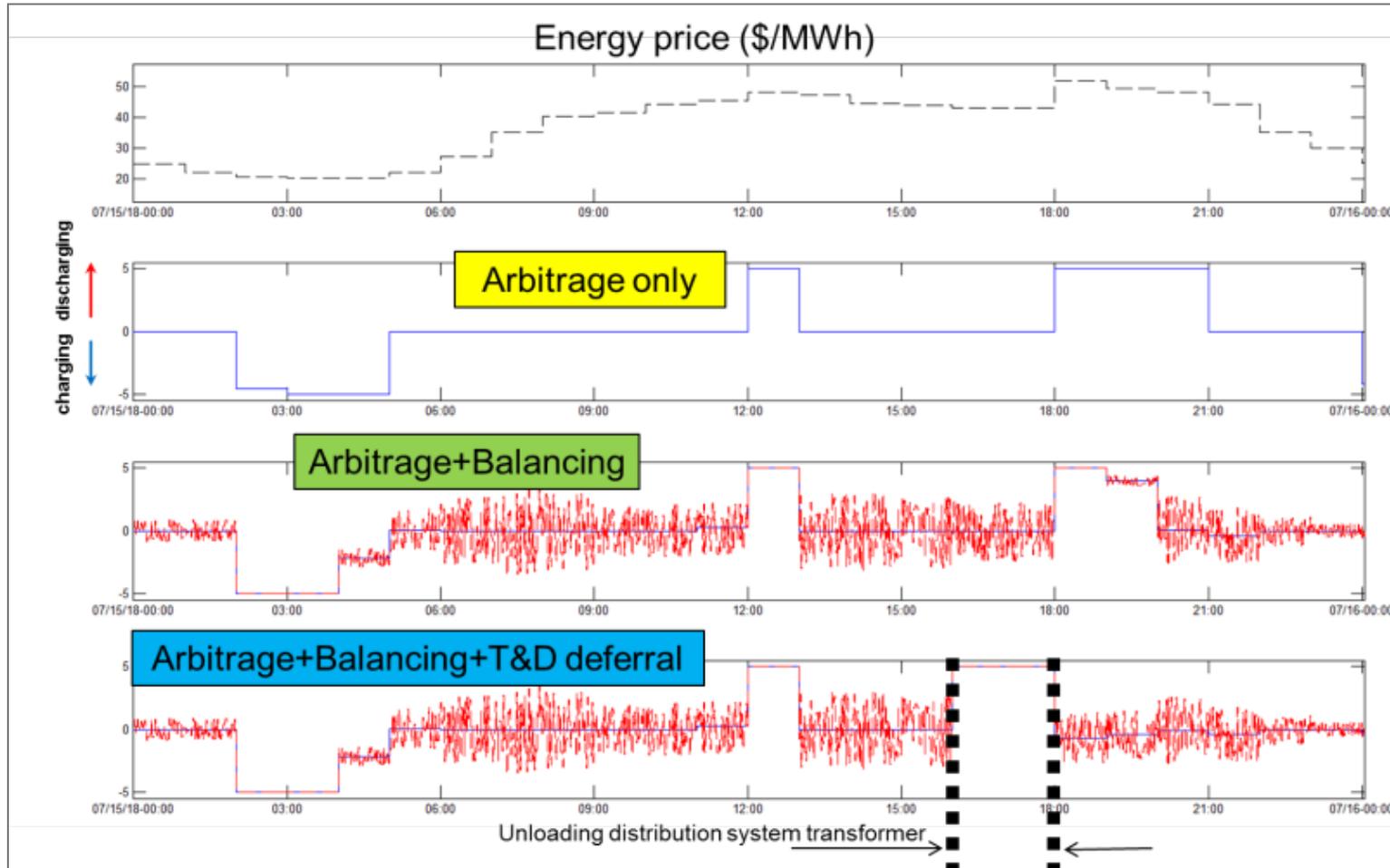
Puget Sound Energy
2 MW / 4.4 MWh lithium-ion/phosphate battery

Snohomish PUD
MESA 1 – 2 MW / 1 MWh lithium-ion battery
MESA 2 – 2 MW / 6.4 MWh vanadium-flow battery

Total – 7 MW / 15 MWh; \$14.3 million state investment / \$43 million total investment for energy storage systems



24-hour Energy Storage Schedule



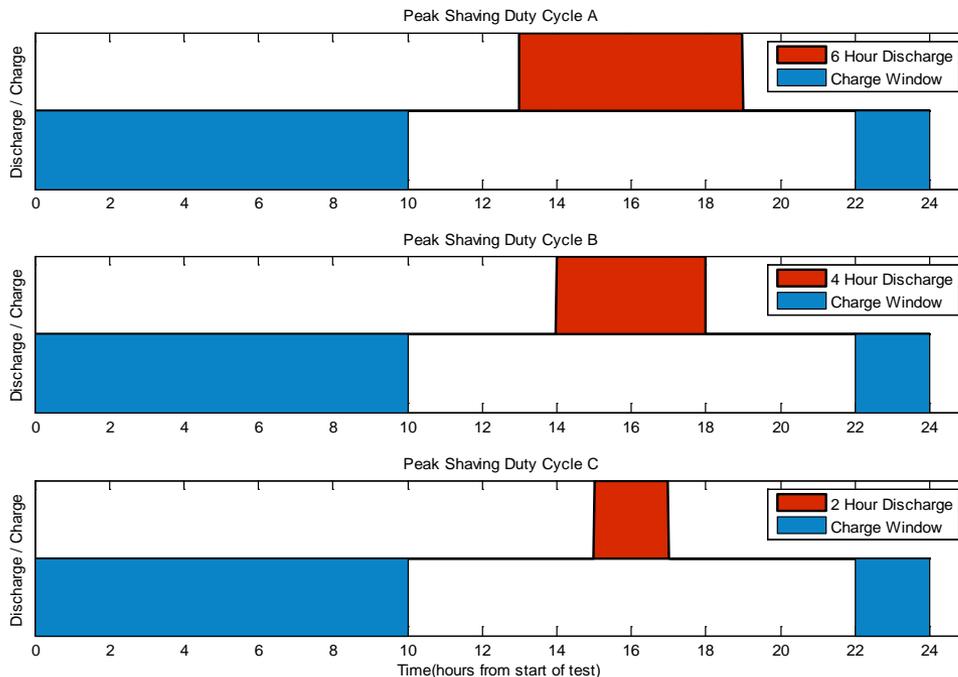
Washington CEF Use Case Matrix

Use Case and application as described in PNNL Catalog	Avista	PSE	Sno – MESA1	Sno – MESA2	Sno - Controls Integration
UC1: Energy Shifting					
Energy shifting from peak to off-peak on a daily basis	Y	Y	Y	Y	
System capacity to meet adequacy requirements	Y	Y	Y	Y	
UC2: Provide Grid Flexibility					
Regulation services	Y	Y		Y*	
Load following services	Y	Y		Y*	
Real-world flexibility operation	Y	Y		Y*	
UC3: Improving Distribution Systems Efficiency					
Volt/Var control with local and/or remote information	Y		Y	Y	
Load-shaping service	Y	Y	Y	Y	
Deferment of distribution system upgrade	Y	Y			
UC4: Outage Management of Critical Loads		Y			
UC5: Enhanced Voltage Control					
Volt/Var control with local and/or remote information and during enhanced CVR events	Y				
UC6: Grid-connected and islanded micro-grid operations					
Black Start operation	Y				
Micro-grid operation while grid-connected	Y				
Micro-grid operation in islanded mode	Y				
UC7: Optimal Utilization of Energy Storage	Y	Y			Y

* A simulated set of signals will be provided by PNNL to test these use cases.

Washington CEF Energy Storage System Testing Program

Peak Shaving Duty Cycles



▶ Technology Behavior Assessment

- Discharge rates
- Effects of the depth of discharge
- Efficiencies
- Transient response
- Accuracy of following signals

▶ Control Strategy Assessment

- Degree to which the service being sought was provided
- Why the service was or was not successfully provided

▶ Testing has begun, or will begin shortly, at Avista and SnoPUD.

Washington CEF - Recent Accomplishments

Category	Accomplishments
1 Kickoff/Scoping	<ul style="list-style-type: none">• Conducted kickoff meetings with each utility• Prepared minutes of each meeting• Revised schedules based on outcome of each meeting
2 Define Technical and Financial Values	<ul style="list-style-type: none">• Prepared an initial set of data requirements• Discussed data requirements with each utility• Refining methods based on individual utility conditions
3 Develop, Test and Validate Data Systems	<ul style="list-style-type: none">• Data collecting framework developed• Data and data systems tested and validated at Avista and SnoPUD• Data concept of operations document prepared
4 ESS Testing	<ul style="list-style-type: none">• Field test plans developed for Avista and SnoPUD,• SNL witness testing of Avista (UET) system• Baseline testing has begun at Avista and SnoPUD

Washington CEF - Next Steps

Task or milestone

Participants

- Develop data acquisition / storage methods and sampling requirements for battery testing
- Test and validate data systems
- Initiate ESS testing
- Initial financial/technical data collection
- Refine methods for estimating value for each utility
- Perform economic assessment of energy storage
- Technical assessment of energy storage system performance

State Activities: Northwest Regulatory Workshop

DOE-OE hosted commissioners and staff of the Northwest (WA, OR, ID, MT) utility regulatory commissions on July 22-23, 2015 at PNNL (w/ DOE-OE and Sandia) on energy storage.

Key presentations:

- ▶ How storage works: components, definitions, system type to services
- ▶ Siting and sizing systems, value stacking and optimized dispatch in the NW
- ▶ Battery chemistries: cost, performance, what we know and where we still need to conduct research

What we heard:

- ▶ *State-by-state engagement:* There is value in regional outreach, but regulatory actions are state-specific.
- ▶ *New tools and methods needed:* Storage is not well-characterized in existing Commission processes.
- ▶ *Independent review:* There is a need for fair and independent arbiters of information about energy storage.

State Activities (Selected): Regulatory Actions for Storage (i.)

WASHINGTON

- ▶ Opened docket UE-151069. Workshop on August 25, 2015.
- ▶ Published draft Staff Paper titled *Modeling Energy Storage: Challenges and Opportunities for Washington Utilities*.
- ▶ A purpose of the docket is “even-handed modeling approach” and “level playing field” for storage.
- ▶ Technology agnostic. Docket outcomes not pre-determined.

OREGON

- ▶ Oregon legislature passed HB 2193 in 2015 session.
- ▶ Directs Oregon PUC to create procurement guidelines for storage by 2017, and if cost-effective, jurisdictional utilities must procure storage with at least 5 MWh capacity by 2020.
- ▶ Docket not yet initiated.

State Activities (Selected): Regulatory Actions for Storage (ii.)

MASSACHUSETTS

- ▶ Energy storage workshop held July 9, 2015, docket 15-ESC-1.
- ▶ June 2014 order (DPU 12-76-B) established requirement for Grid Modernization plans, a 10-year plan that must include a 5-year short-term investment plan (STIP).
- ▶ Grid Modernization plans filed August 2015. All propose energy storage engagement in their RD&D programs.
 - Docket 15-120 for National Grid
 - Docket 15-121 for Unitil (Fitchburg Gas and Electric)
 - Docket 15-122 for Eversource

- ▶ **Washington CEF analytical work initiated**
 - Establish a framework for benefits analysis of energy storage,
 - Evaluate technical and financial performance
 - Exploring the value that energy storage can deliver to Washington utilities and their customers
- ▶ **Evaluating a broad set of use cases for energy storage at Avista, PSE and SnoPUD**
 - Energy shifting
 - Grid flexibility (regulation services, load following, real-world flexibility operation)
 - Improving distribution systems efficiency (Volt/VAR control, load-shaping service, distribution investment deferral)
 - Outage management
 - Grid-connected and islanded microgrid operations (black start operation, microgrid operation while grid-connected, microgrid operation in islanded mode)
- ▶ **Despite initial utility delays, two of the five systems have been deployed and are being tested**
- ▶ **ESS to be tested to evaluate performance and develop optimal dispatch algorithms.**
- ▶ **The Washington CEF complements regional strategy to advance energy storage including regulatory interfaces.**