Washington State Clean Energy Funds (CEF) – Grid Storage

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Grid Analysis

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OE Energy Storage Systems Program Review

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WA State CEF: Grid Scale Energy Storage

- Background
  - Fall of 2013, WA-State Legislature allocated $15 million for implementing innovative energy storage projects
  - Matching required by retail electric utilities.
- Objectives
  - Integrate intermittent renewable energy projects through energy storage
  - Demonstrate dispatch of energy storage resources from utility energy control centers
  - Improve reliability and reduce cost of intermittent or distributed energy resources

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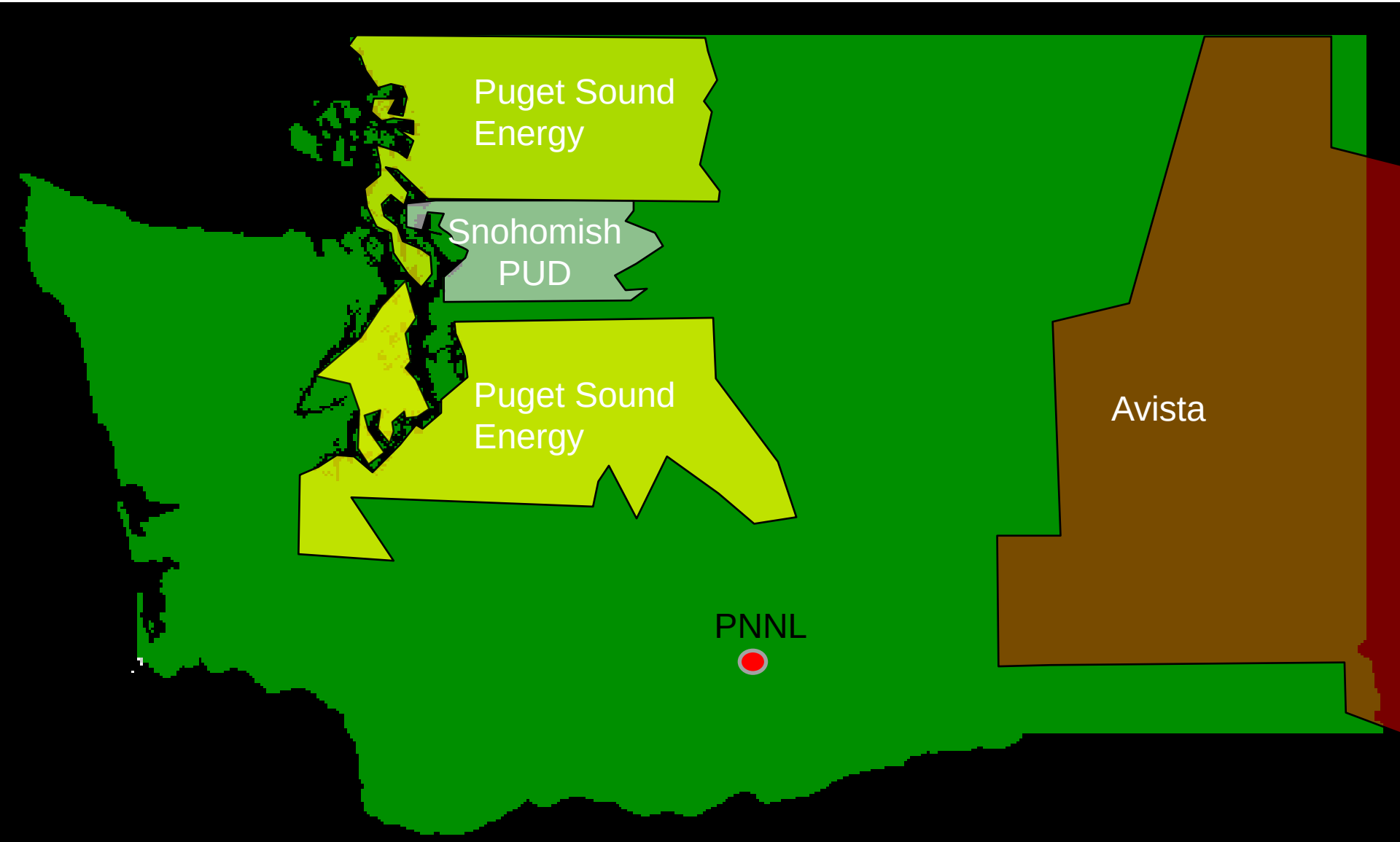
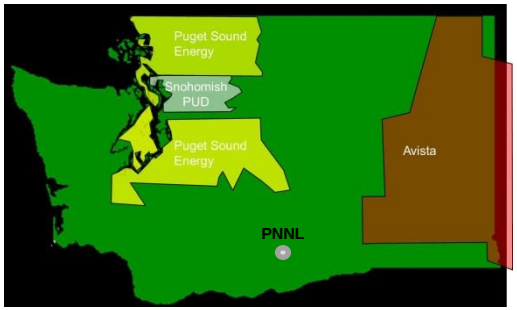
3 Awardees: Avista, Puget Sound Energy, Snohomish PUD



Project Overview



- Avista
  - field test a 1-MW, 3.2-MWhr UniEnergy vanadium-flow battery assembly in a three-year demonstration project at a substation in Pullman, Wash.
- Puget Sound Energy
  - deploy a 2-MW, 4.4-MWhr lithium-ion/phosphate battery assembly at a yet-to-be announced location.
- Snohomish PUD
  - MESA 1 project will deploy two 1-MW, 500-MWhr lithium-ion battery based systems within one substation. These two large-scale lithium-ion battery assemblies, one built by LG Chem and a second by Mitsubishi-GS Yuasa, will each use a Parker Hannifin Power Conversion System.
  - MESA 2 project, at a different substation, will deploy multiple advanced vanadium-flow battery assemblies, built by UniEnergy Technolgies, having total combined ratings of 2MW/6.4MWhr.
- PNNL
  - perform technical and economic use-case analyses, dispatch optimization, and performance monitoring

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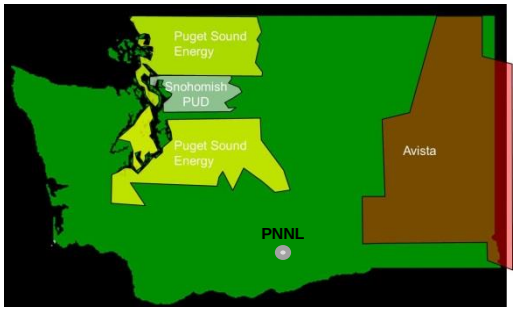
PNNL's Role and Scope of Work

- Honest evaluator of both technical and economic performance of energy storage based on the following use cases:
  - **Transmission System**
    - Use-case 1: Energy shifting
    - Use-case 2: Provide Grid Flexibility (Regulation, Load Following, …)
  - **Distribution systems**
    - Use-case 3: Improving Distribution Systems Efficiency (Volt-VAR, Load Shaping)
    - Use-case 4: Outage Management of Critical Loads
    - Use-case 5: Enhanced Voltage Control (Volt-VAR with advanced CVR)
  - **Micro-Grid Operations**
    - Use-case 6: Grid-connected and islanded micro-grid operations (MG and Black Start)
  - **Maximizing Total Value of Storage**
    - Use-case 7: Optimal Utilization of Energy Storage using co-optimization of all of the use-cases above
- DOE-WADOC MOU, CRADA w/PNNL (cost shared)
- Control Systems w/AVISTA (cost shared)

Performance Testing



- Technical Performance Testing
  - Utilizing performance testing protocols (SNL/PNNL)
  - Ramping performance
  - Accuracy to follow signal
  - Meeting all design specifications
  - Capacity fading
  - Optimal dispatch
- Economic Performance Testing
  - Data requirements
    - Time series of value estimation for each service that drive the maximization of value.
    - Starting and ending times of optimization of services.
    - Time series of charging and discharging operational commands from the ESS control system
    - Time series of charging and discharging measured at the AC side of the machine (in kW or VA) at time intervals either at SCADA sampling rates or at 1 minute-rates. Where available, the measurements will also be performed on the DC side of the inverter.
    - Time series of State of charge
    - Any error messages from the ESS that could be from individual components within the ESS,

    Financial data
    - Before tax, & after tax, weighted cost of capital.
    - O&M escalation rate
    - Capital escalation rate
    - Insurance rate
    - Federal income tax rate
    - Property tax rate
    - State revenue tax rate

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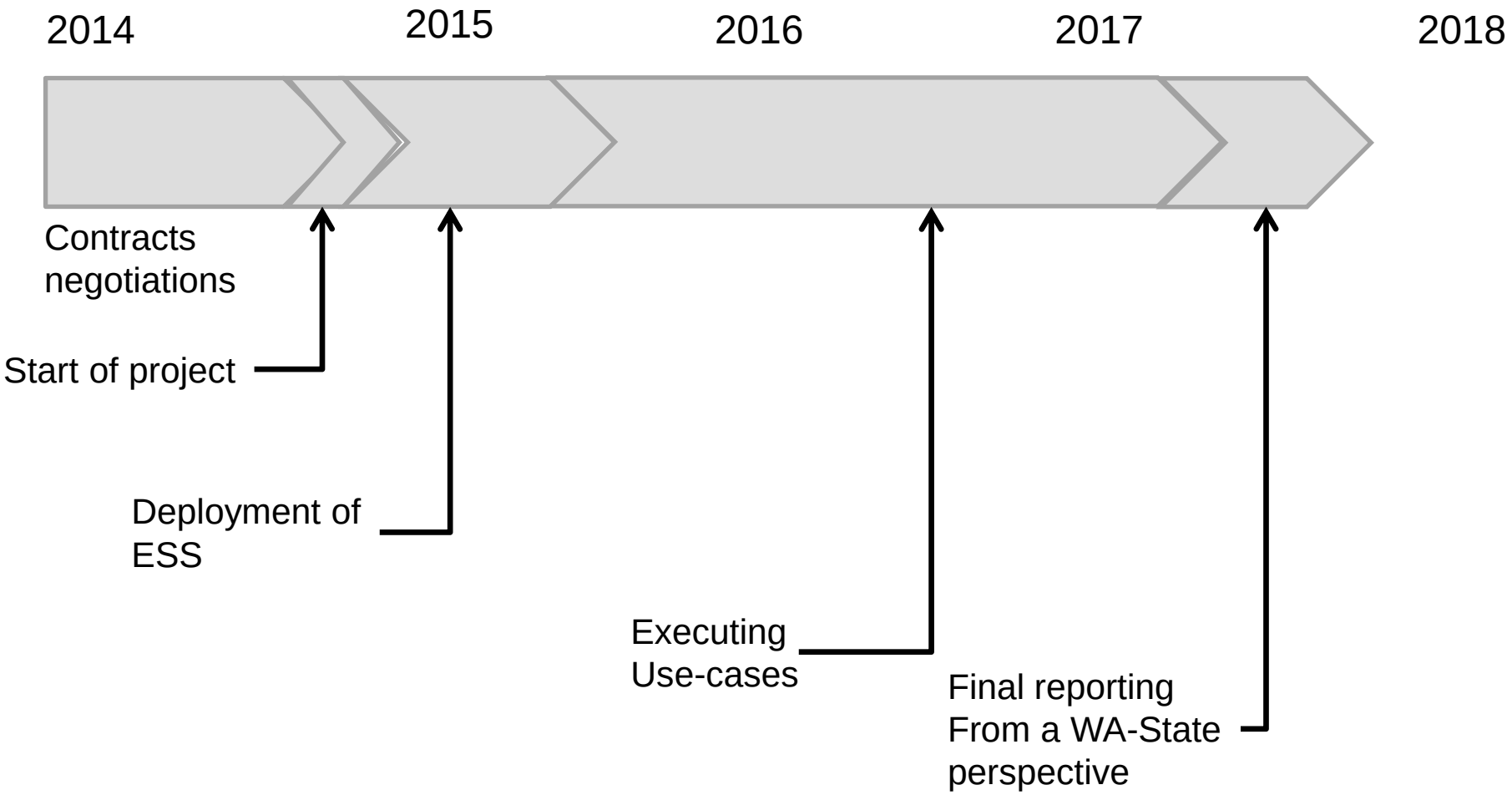
Timeline



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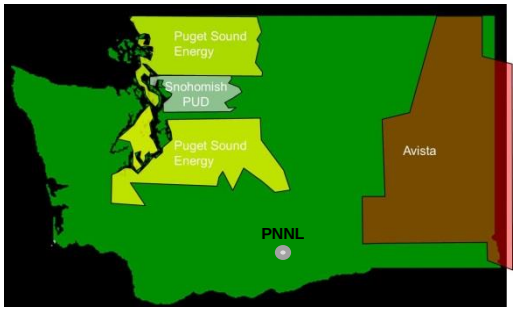
Expected Outcome of Project



- Insights into technical performance of
  - accuracy of following a signal
  - fading of performance
  - ability to provide volt/VAR control
- Testing of usefulness of performance testing protocols (SNL/PNNL)
- Insights into cost-effective applications for PNW conditions (high wind penetration, low differential peak/off-peak energy)
- Insights into the need for optimal control strategies to attain levels of cost-effectiveness
- Insights into “nuts and bolts” for designing and siting grid-connected ESS
- Evaluation of financial and non-financial factors, especially for multiple benefits

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