

# Energy Storage Grid Scale Testing

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# Grid Scale Energy Storage Testing

- ▶ Washington clean energy funds and US DOE-OE sponsored ESS integration with grid at 3 utilities
- ▶ Li-ion Systems 1 to 5 MWh; 2 to 4 MW
- ▶ Flow Battery Systems 1 to 2 MW, 4 to 8 MWh
- ▶ Used US DOE-OE Performance Protocol (Sandia-PNNL led) for Reference Performance Tests
- ▶ Developed duty cycles for various use cases
  - Energy shifting
  - Grid Flexibility
  - Outage Mitigation
  - Microgrid
  - Conservation Voltage Reduction
  - Volt-Vars

- ▶ Round Trip Efficiency
  - With Auxiliary consumption
  - Without Auxiliary consumption
- ▶ Response Time
  - Communication lag
  - Hardware lag
  - Time to target power
- ▶ Ramp Rate – from time to rated power
- ▶ Internal Resistance as  $f(\text{SOC})$ 
  - Go under the hood  $\Delta V / \Delta I$  ( $\Delta \text{SOC} < 0.1\%$ )
    - does ramp rate depend on this parameter?
- ▶ Signal Tracking
  - Tracking at grid level different from tracking at inverter level
    - Need to ensure ESS tracks command signal at grid level

- ▶ No one size fits all
- ▶ Different energy to power ratio of BESS applicable for different use cases
- ▶ RTE important for arbitrage
  - Depends on power as percent of rated power
  - Auxiliary consumption
  - Inverter efficiency at various power levels
  - For some applications, RTE may be 0
    - Read the report!
- ▶ Signal tracking important for volatile applications
- ▶ Performance model to predict performance
  - Being modified to predict degradation

- ▶ US DOE-OE sponsored Performance Protocol is the industry standard
  - EPRI ESIC has liberally used this and tweaked it for industry use
  - PNNL has performed 5 projects using this Protocol
- ▶ Additional metrics developed as part of these projects
- ▶ Duty cycles for various use cases developed
- ▶ Economic analysis done to identify technologies and energy/power ratios optimum for various use cases
- ▶ Protocol for Reference Performance Tests has been converted to IEC TC120 standard
- ▶ US and Japan will co-lead effort to develop standard for use cases
  - Again using the US DOE-OE Performance Protocol
- ▶ ANSI is also converting the Protocol into a standard
- ▶ IEEE PES ESSB is starting a working group on Flow Battery Standards development

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