

Realization of Energy Storage Economic Benefits: Managing Changes in Real Time

**Presented by
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DOE Energy Storage Program Annual Peer Review

29th September to 1st October, 2020

Background and Motivation

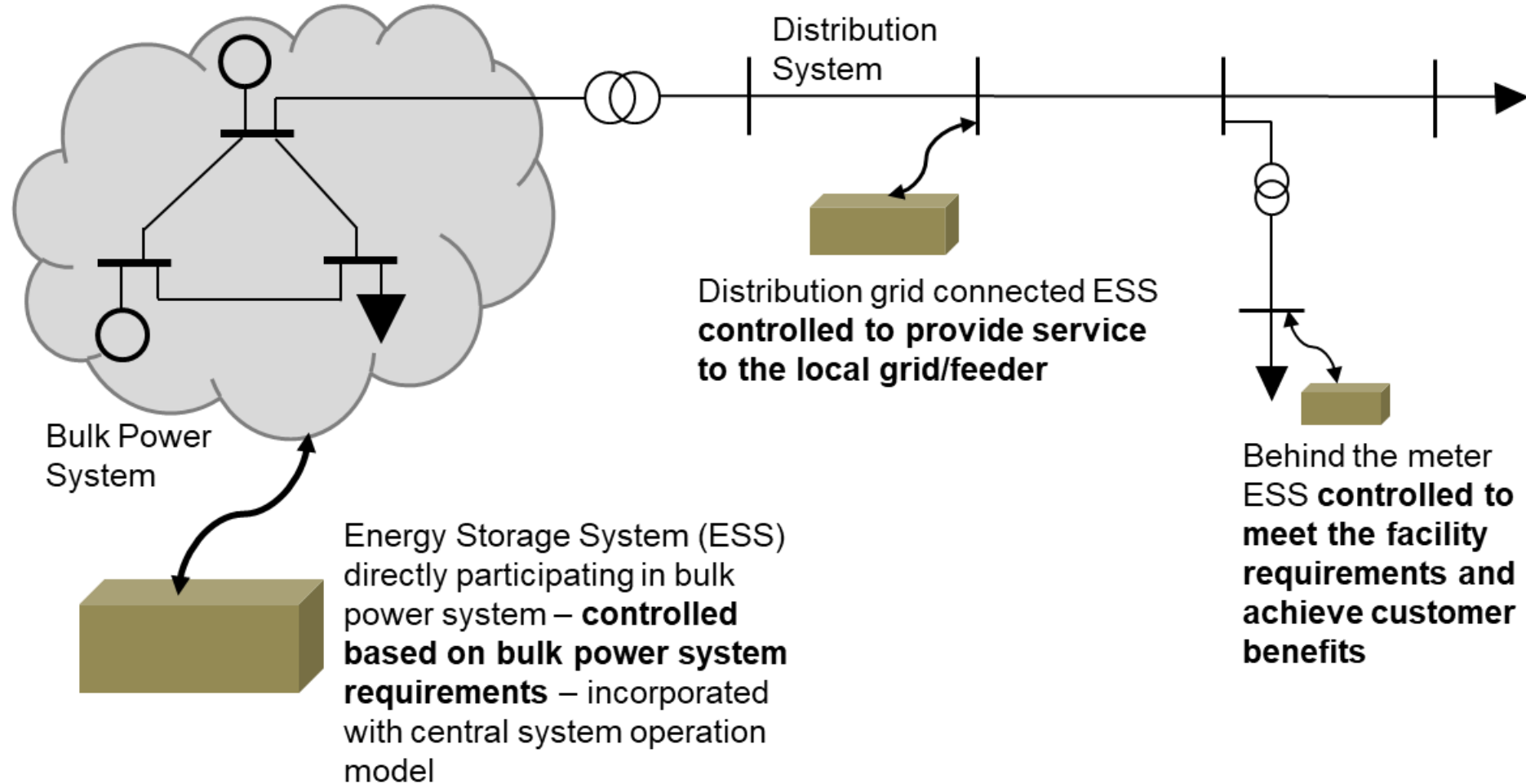
- Decision on acquiring energy storage assets is highly motivated by potential benefit streams.
- Financial and economic analyses help evaluate feasible benefit streams in the planning phase.
- However, operation phase may significantly differ than planning and create challenges.
- Capability to manage those changes needed to realize the anticipated benefits.



Portland General Electric implemented a multi-service control strategy for the 5 MW/1.25 MWh Lithium-ion ESS at Salem Smart Power Center, Salem, Oregon, USA

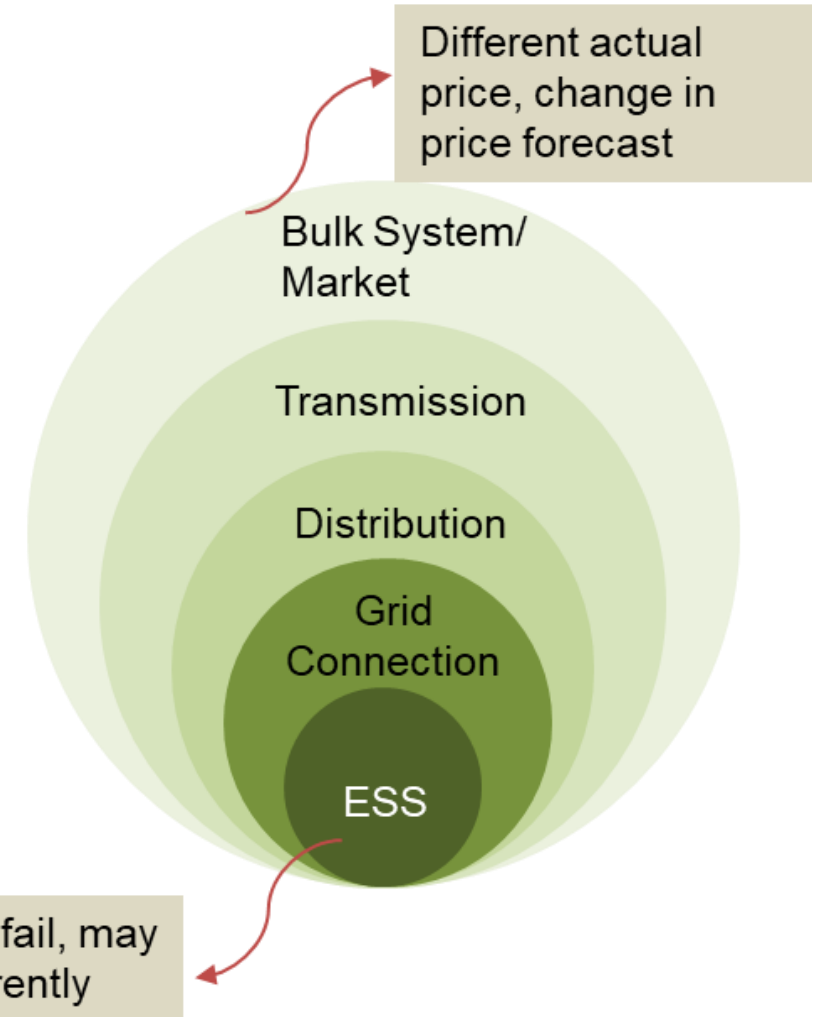
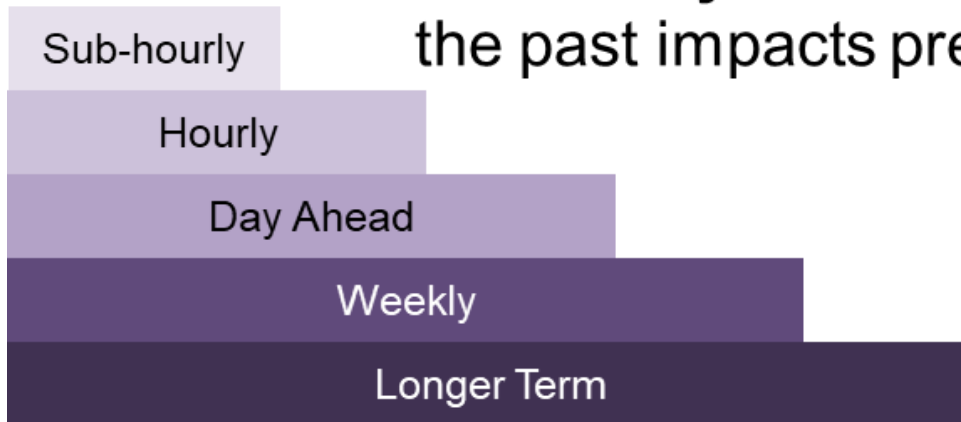
J. Alam, P. Balducci., K. Whitener, and S. Cox, "Energy Storage Control Capability Expansion: Achieving Better Technoeconomic Benefits at Portland General Electric's Salem Smart Power Center", IEEE Power and Energy Magazine, Vol. 18, Issue 2, Feb/Mar 2020.

Energy Storage Control: An Overview



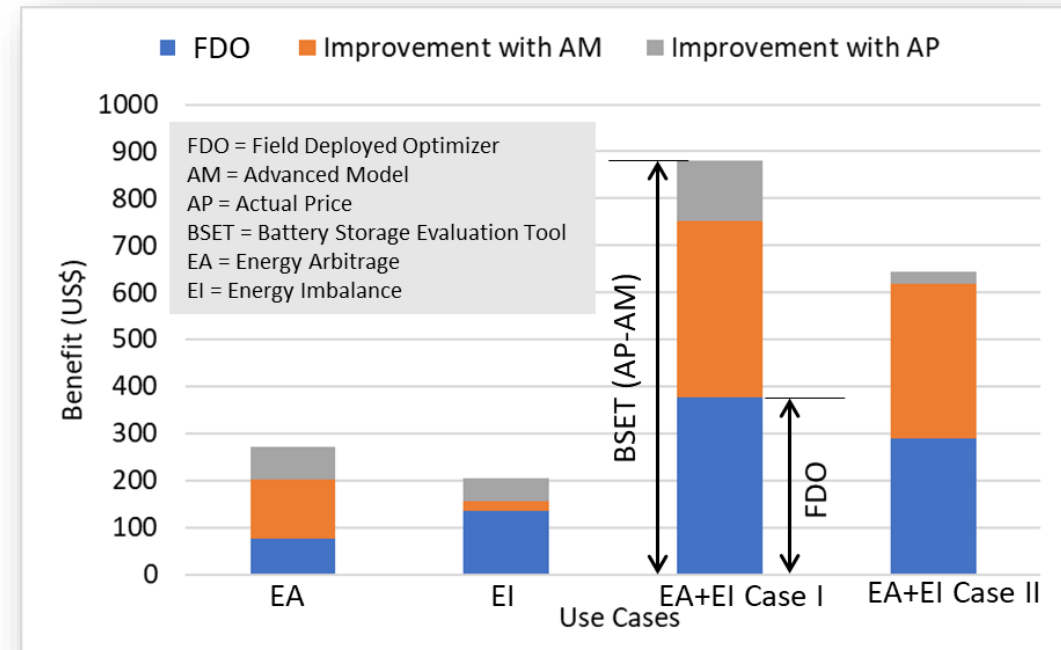
Energy Storage Control: What Could Go Wrong?

- ESS control involves decision making in response to changes and uncertainties at various levels of **time and location**
- **Memory effect** – what is done in the past impacts present and future



Real-Life Example: Benefit Lower than Anticipated

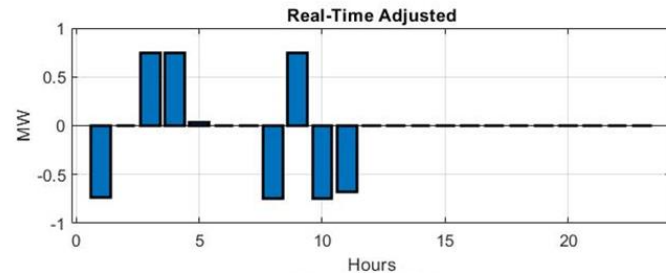
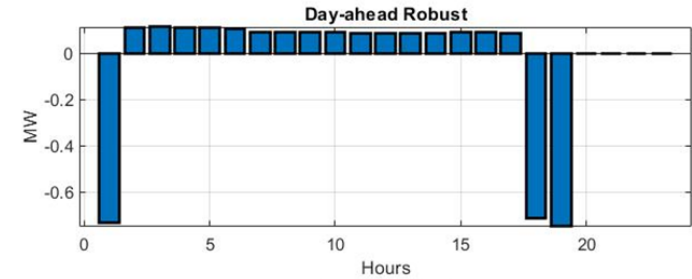
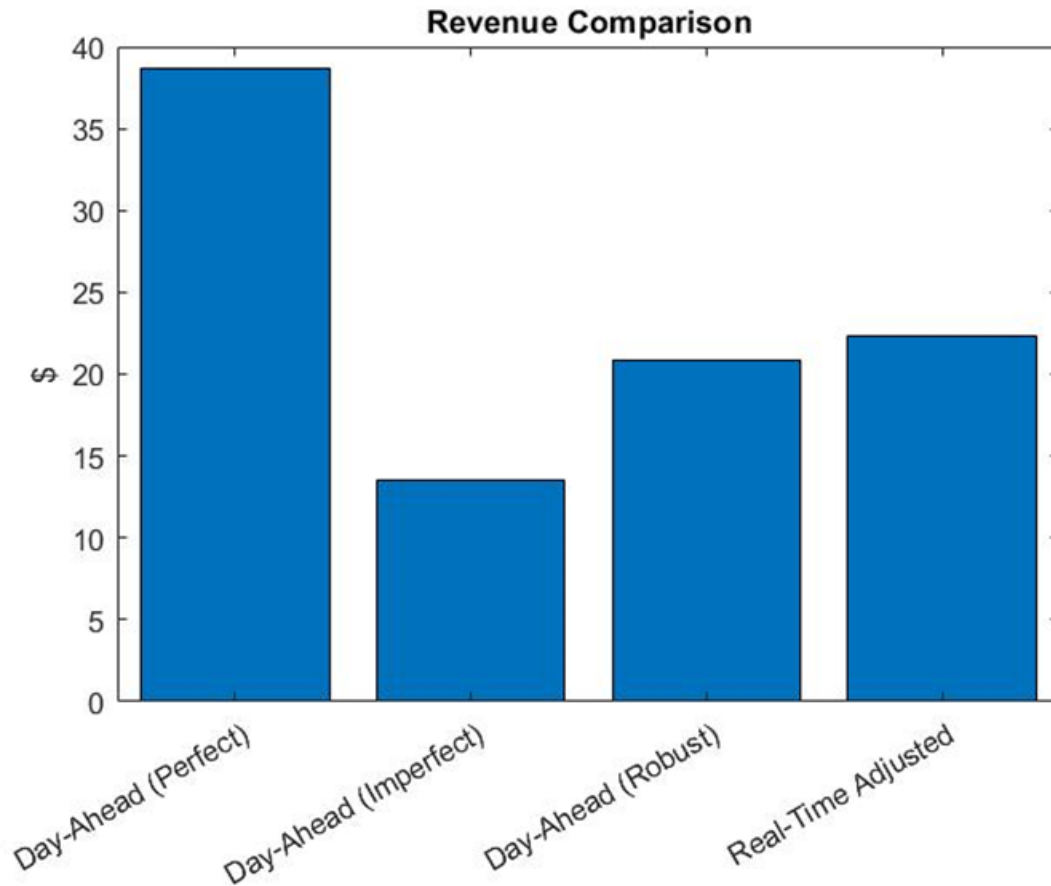
- A multi-string ESS installation in Washington, USA experienced frequent string failure at the initial stage of operation
- The state of charge (SoC) changed differently than typically assumed (first order linear SoC model)
- Actual energy price varied than the forecast
- Caused financial benefit to decline



Understanding 'what could go wrong' and incorporating mitigation measures with control strategies are of key importance in realizing anticipated ESS benefits.

Dealing with the Changes: Real Time Price and Updated Price Forecast

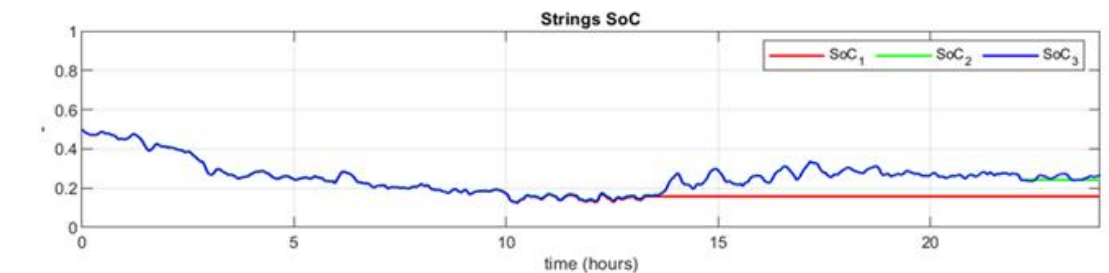
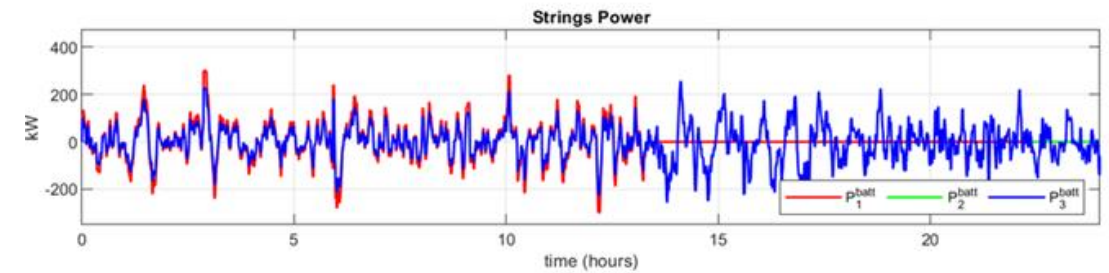
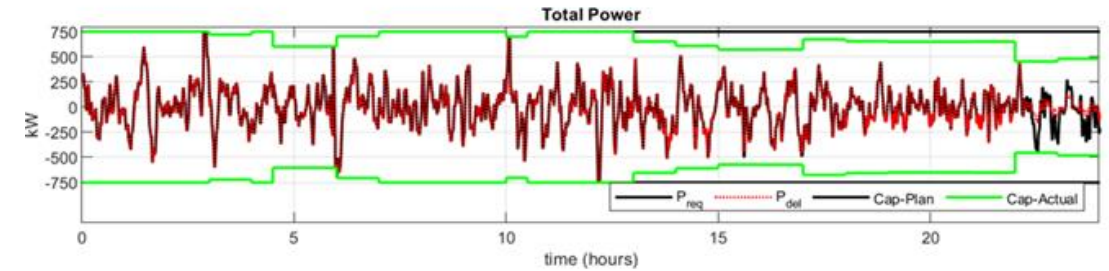
Adjustment in response to real time changes in price and price forecast could enhance revenue.



Dealing with the Changes: Partial String Failure in Multistring ESS

Making real time adjustments in ESS control duty cycles in response to string failure could reduce mismatch penalty and enhance revenue.

Scenarios	Planning/Real-Time Adjustment	Capacity Payment (\$)	Mismatch Penalty (\$)	Revenue (\$)
S1	No/No	324	297	27
S2	No/Yes	320	105	215
S3	Yes/No	287	215	72
S4	Yes/Yes	297	57	240





Acknowledgement



U.S. DEPARTMENT OF
ENERGY

Dr. Imre Gyuk, Office of Electricity, U.S. Department of Energy



Mr. Bob Kirchmeier, Clean Energy Fund, Washington State Department of Commerce

Questions and Comments

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