Energy Storage as a Non-Wires Alternative for Distribution Asset Deferral and Customer Bill Reduction

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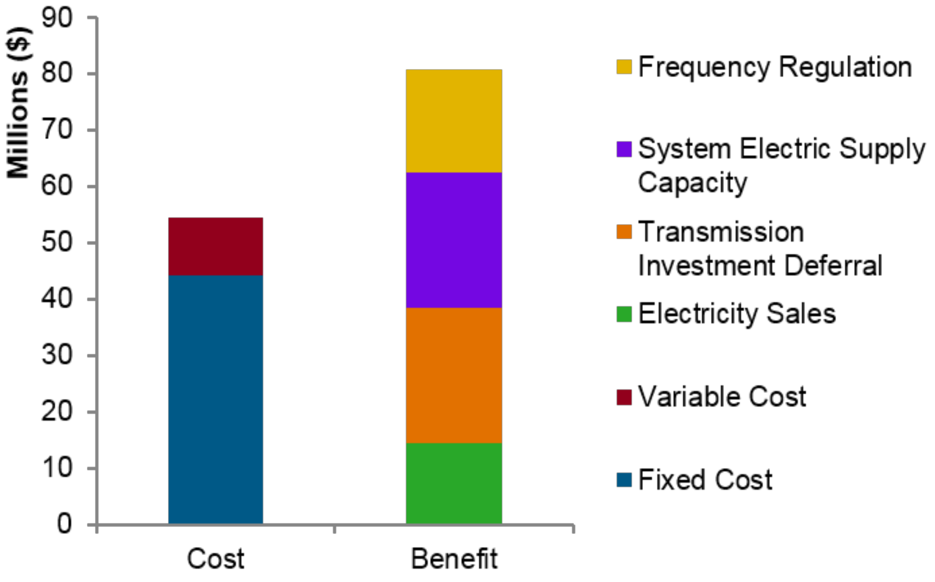
Stacked-Benefit Operations: Value & Benefits

Stacked-benefit operation adds services that can generate new value streams and improve economic viability of storage but also adds complexity



Transmission Services	Distribution Services	Customer Services
Ancillary Services	Deferral of distribution upgrades	Demand charge reduction
Renewable Shifting / Smoothing	PV Smoothing	Retail Energy Arbitrage
Voltage / Reactive Power Support	Voltage / Reactive Power Support	Backup Power
Capacity / Congestion relief	Increase PV accommodation	Demand Response
Deferral of transmission upgrades	Power Quality improvement	

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Energy Storage Analysis Supplemental (EPRI 3002011930)

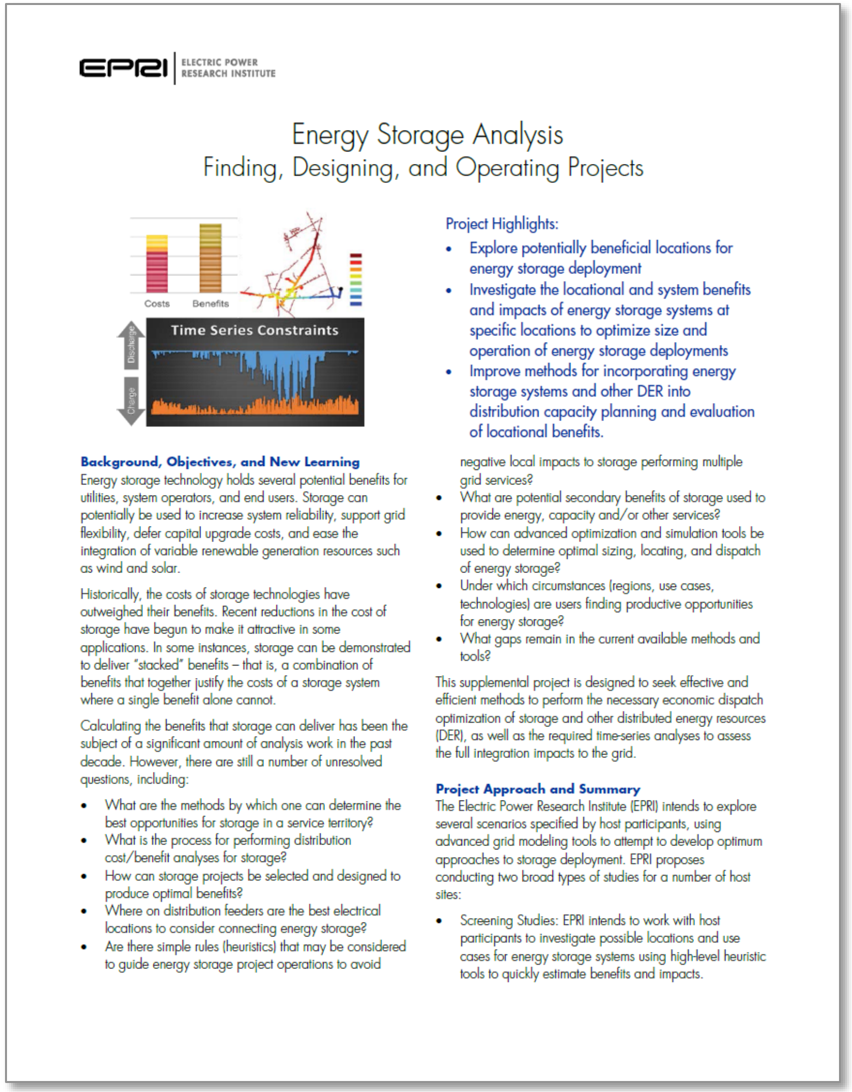
To address these research questions, EPRI and members developed the Analysis Supplemental Project

Objectives

- Determine Optimal storage *siting, sizing and operation*
- Develop *valuation methods* of specific storage *use cases* and *locations*
- *Evaluate* feeders from *different utility service territories*
- Improve methods for *incorporating energy storage* into transmission & distribution *planning*

Approach

- Analyze storage deployments with multiple host utilities over a 3-year project window
- *Integrated* use of analysis tools including OpenDSS, DRIVE, and StorageVET
- Report on analyses, deployments, and *lessons learned*



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Energy Storage Analysis
Finding, Designing, and Operating Projects

Project Highlights:

- Explore potentially beneficial locations for energy storage deployment
- Investigate the locational and system benefits and impacts of energy storage systems at specific locations to optimize size and operation of energy storage deployments
- Improve methods for incorporating energy storage systems and other DER into distribution capacity planning and evaluation of locational benefits.

Background, Objectives, and New Learning

Energy storage technology holds several potential benefits for utilities, system operators, and end users. Storage can potentially be used to increase system reliability, support grid flexibility, defer capital upgrade costs, and ease the integration of variable renewable generation resources such as wind and solar.

Historically, the costs of storage technologies have outweighed their benefits. Recent reductions in the cost of storage have begun to make it attractive in some applications. In some instances, storage can be demonstrated to deliver "stacked" benefits – that is, a combination of benefits that together justify the costs of a storage system where a single benefit alone cannot.

Calculating the benefits that storage can deliver has been the subject of a significant amount of analysis work in the past decade. However, there are still a number of unresolved questions, including:

- What are the methods by which one can determine the best opportunities for storage in a service territory?
- What is the process for performing distribution cost/benefit analyses for storage?
- How can storage projects be selected and designed to produce optimal benefits?
- Where on distribution feeders are the best electrical locations to consider connecting energy storage?
- Are there simple rules (heuristics) that may be considered to guide energy storage project operations to avoid negative local impacts to storage performing multiple grid services?
- What are potential secondary benefits of storage used to provide energy, capacity and/or other services?
- How can advanced optimization and simulation tools be used to determine optimal sizing, locating, and dispatch of energy storage?
- Under which circumstances (regions, use cases, technologies) are users finding productive opportunities for energy storage?
- What gaps remain in the current available methods and tools?

This supplemental project is designed to seek effective and efficient methods to perform the necessary economic dispatch optimization of storage and other distributed energy resources (DER), as well as the required time-series analyses to assess the full integration impacts to the grid.

Project Approach and Summary

The Electric Power Research Institute (EPRI) intends to explore several scenarios specified by host participants, using advanced grid modeling tools to attempt to develop optimum approaches to storage deployment. EPRI proposes conducting two broad types of studies for a number of host sites:

- Screening Studies: EPRI intends to work with host participants to investigate possible locations and use cases for energy storage systems using high-level heuristic tools to quickly estimate benefits and impacts.

Framework for Analyzing Energy Storage as a Non-Wires Alternative

1. Scenario Development

2. Distribution Assessment

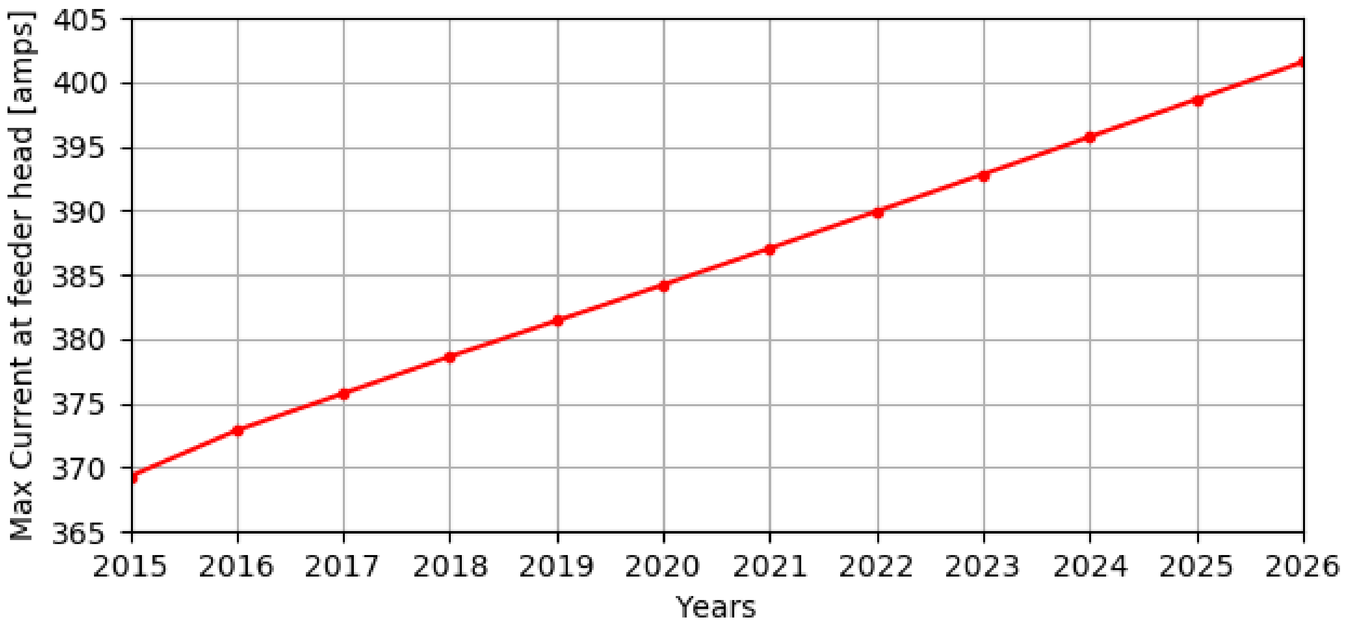
3. Non Distribution Assessment

4. Cost Benefit Analysis

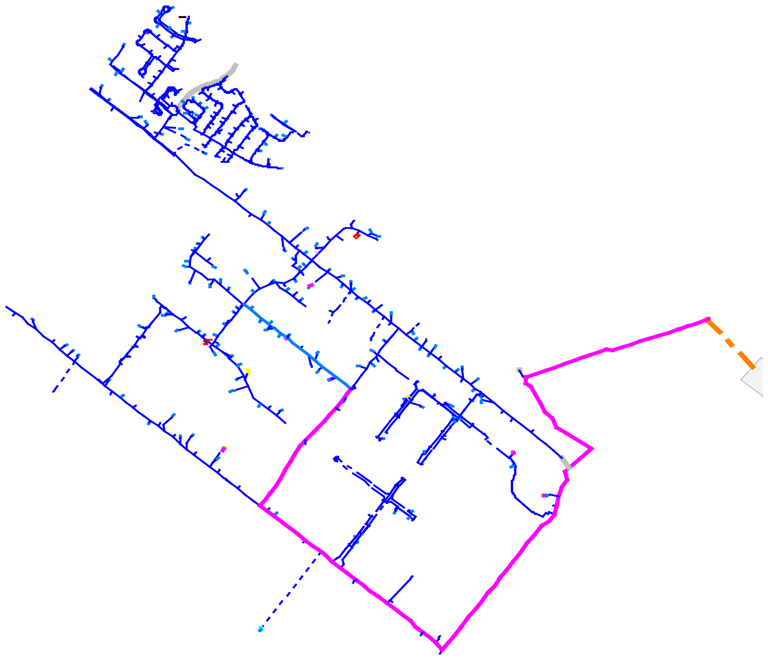
Case Study Motivations

The head of the selected feeder has high peak currents that are getting close to the maximum permitted under standard utility practices

Feeder Head Currents Based on Load Growth Forecast



High Feeder Head Peak-Time Currents



Involving multiple utility stakeholders is key to identifying the relevant technical problem(s) to be addressed, and deciding on the range of possible mitigation measures to employ.

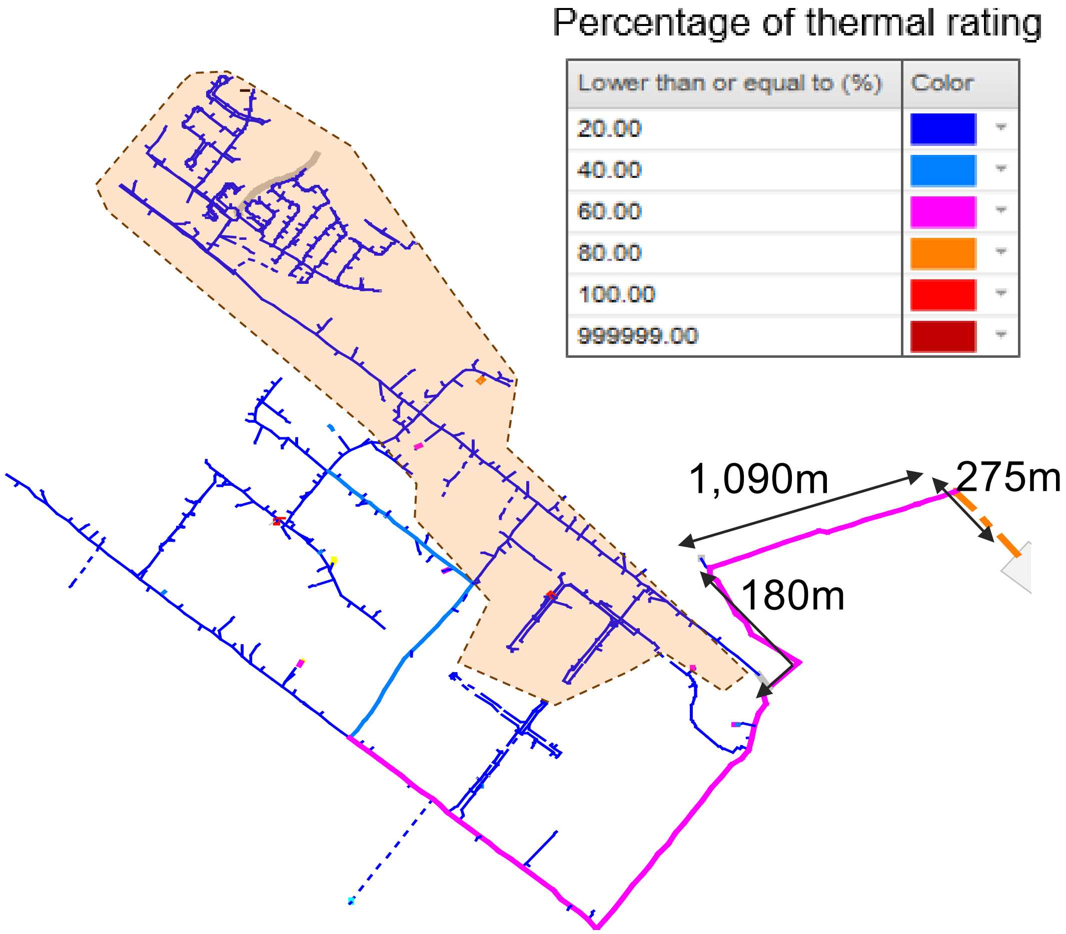
Conventional Measures to Mitigate High Peak Currents

Network Reconfiguration

- Due to expected aggressive load growth in feeder area, reconfiguration is not considered an option in this case

Reconductoring

- Construction of a new distribution line from the problematic feeder to an adjacent feeder shown in green
- The reconductoring alternative addresses current and future capacity needs



This study considers **reconductoring** as the **conventional mitigation measure** for the feeder considered

Alternative Mitigation Measure: Energy Storage

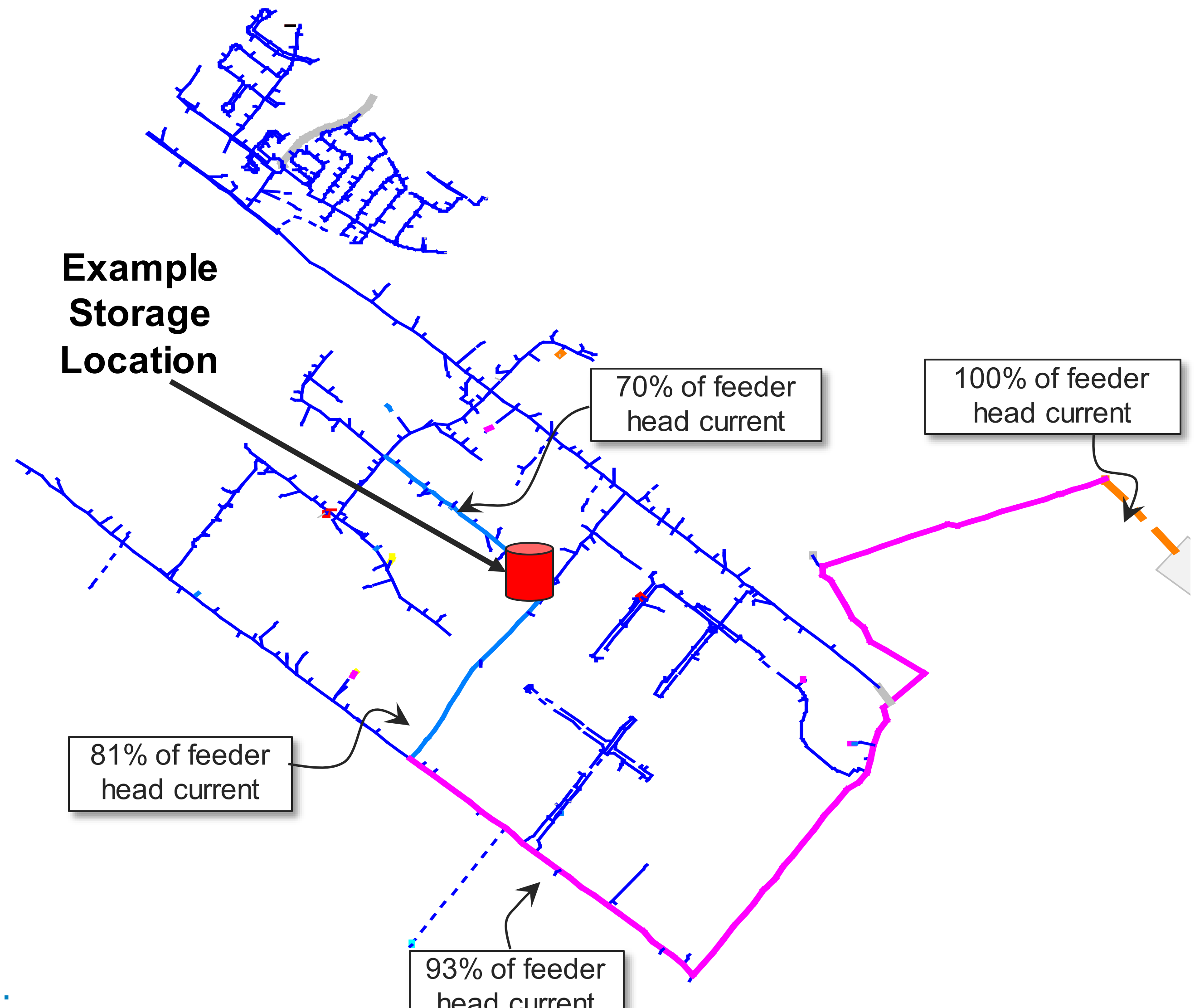
Scenario

- Customer owned and operated energy storage
- ***Primary objective***: Maintain feeder head peak currents below maximum permitted.
- ***Secondary objective***: Minimize the customer's bill within operating constraints set by primary objective

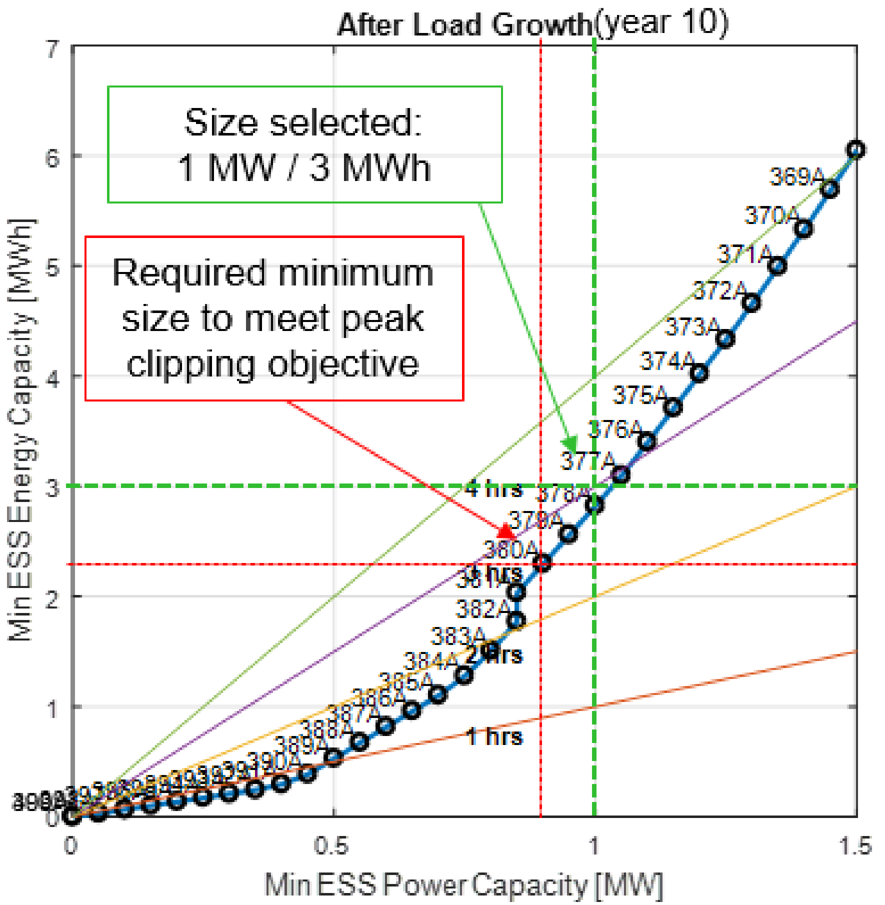
Storage Placement

For capacity deferral, storage is placed downstream of all the elements that are capacity-constrained (under all considered reconfigurations)

Alternative Mitigation Measure: Energy Storage



Peak Clipping Objective & Storage Sizing



This study considers deploying a **1MW/3MWh storage system** as the **alternative mitigation measure** for the feeder considered

Components of the Customer Bill

Energy Components, 2016 data

Item	Actual Value
Energy Price	Locational Marginal Price (LMP)
Energy Price Adders	$0.0123/kWh
Transmission & Distribution Charges **(Demand Charges)**	$6.7905/kW
Global Adjustment **(Coincident Demand Charges)**	Calculated annually based IESO GA Costs

Peak Hours Forecast for Demand Charge Reduction

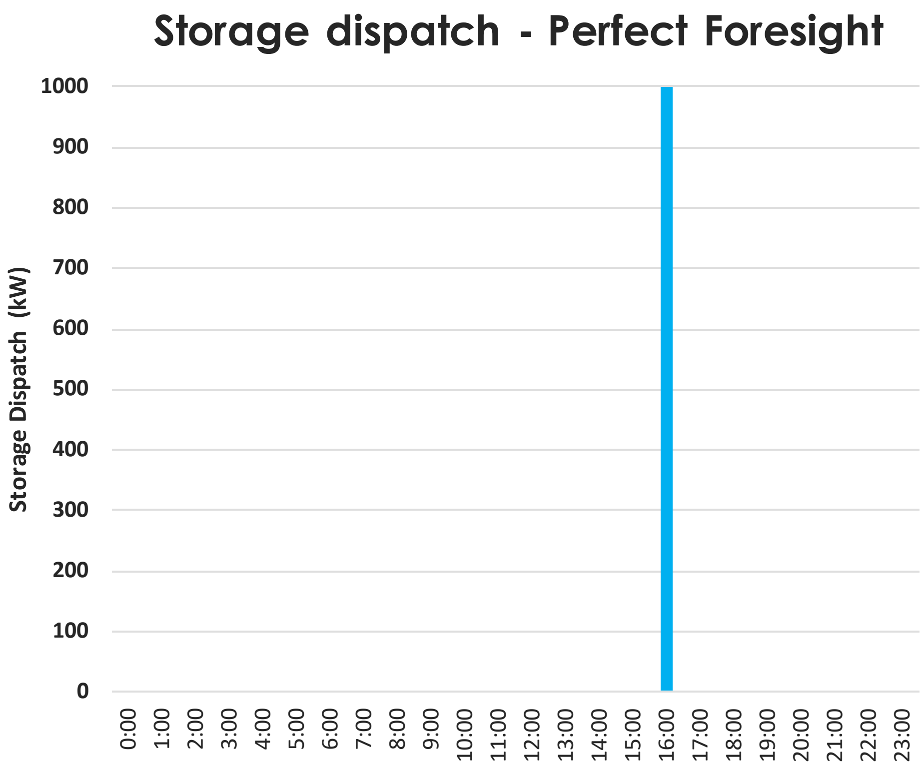
The *Global Adjustment* calculation is based on the customer's demand during the top 5 annual peaks of the system's load.

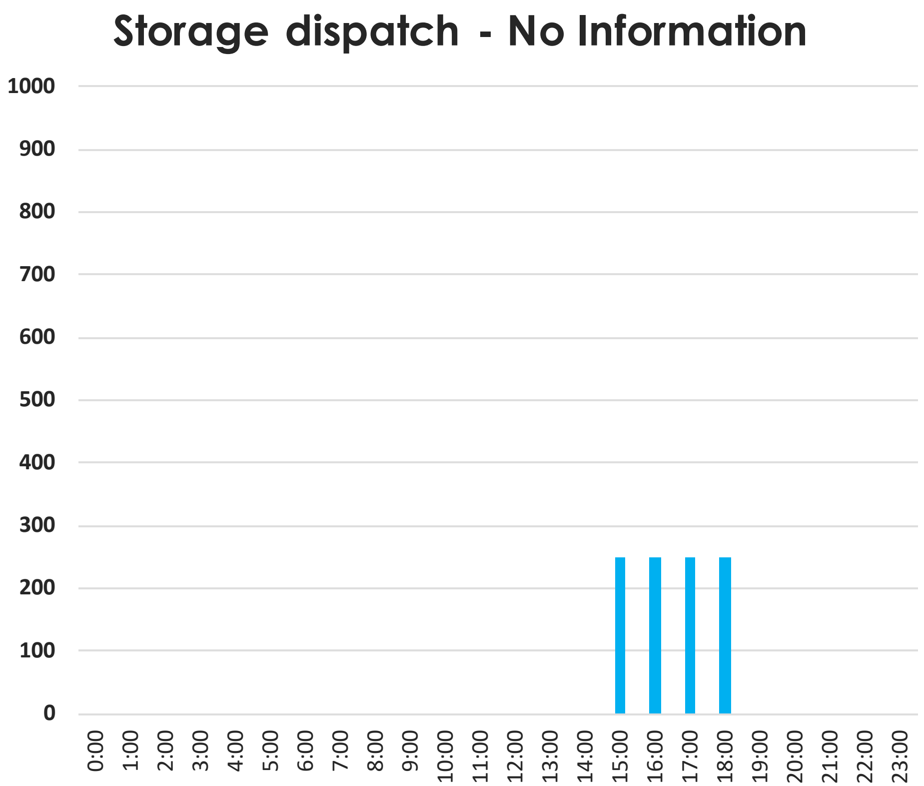
A) Perfect Foresight

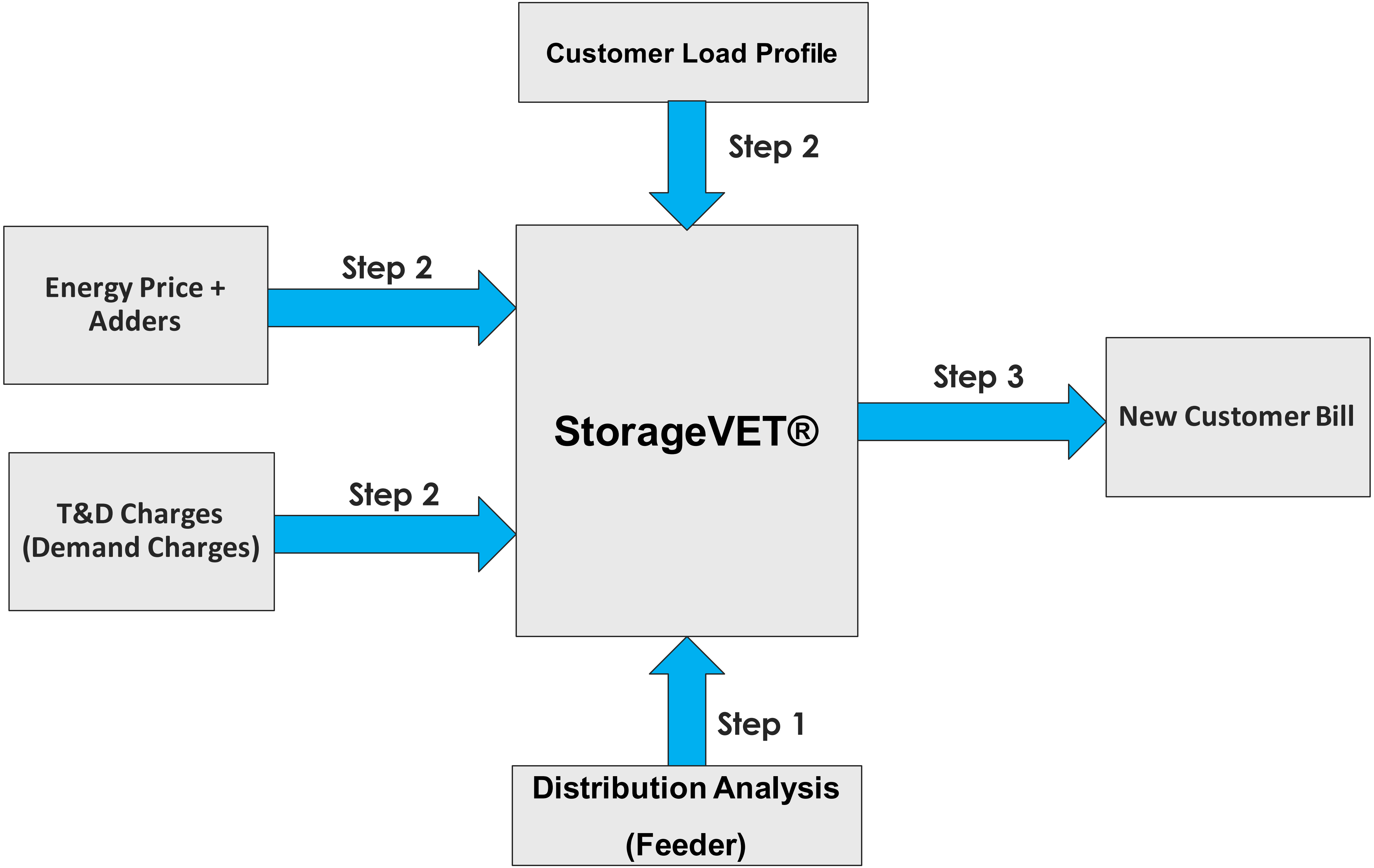
- Storage is scheduled to discharge at maximum capacity (1 MW) for the entire duration of the peak.

B) No Information

- Storage is scheduled to discharge 250 kW for each of the four hours from 15:00 to 19:00 during the weekdays of the summer months (June – September)

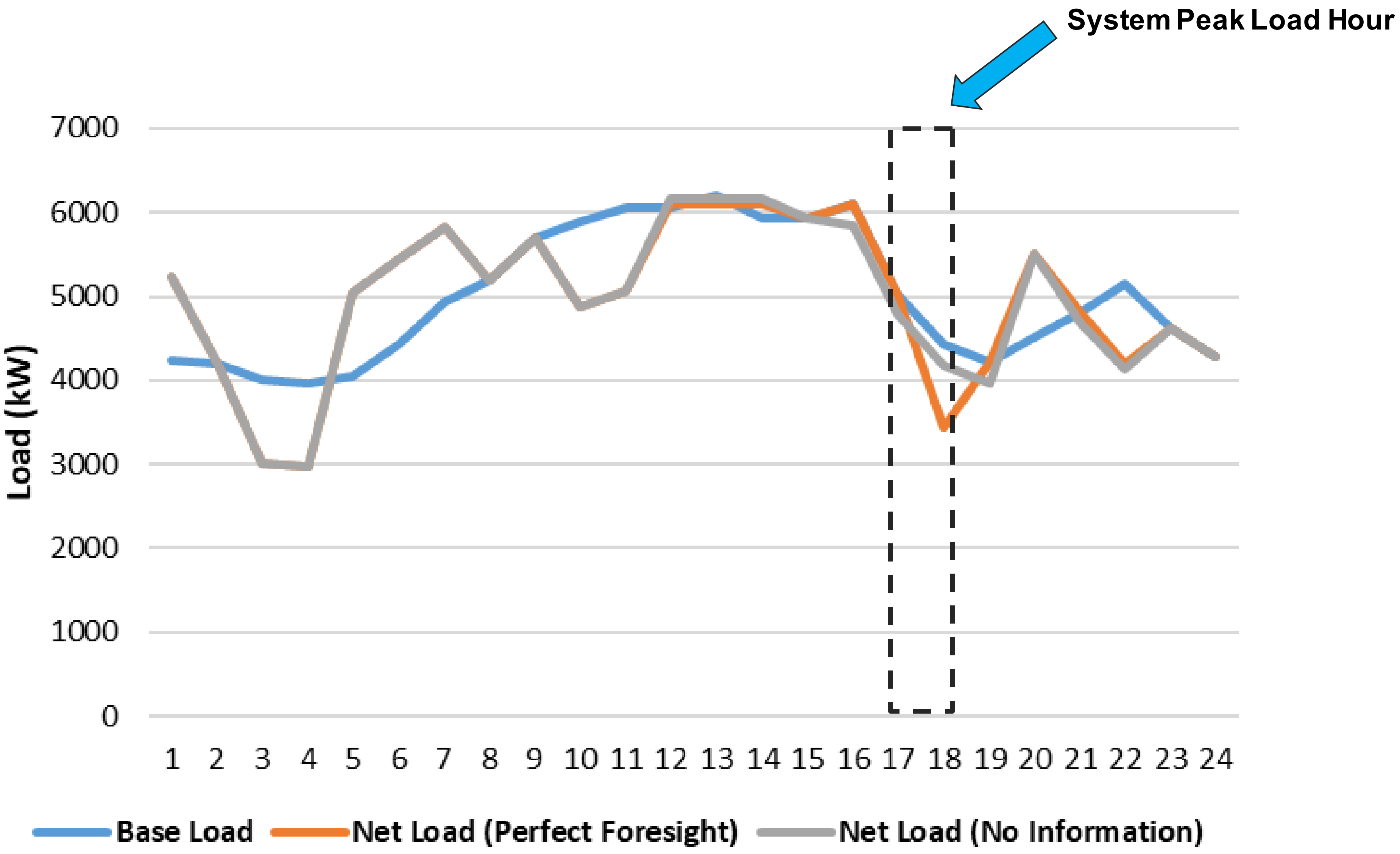





Customer Load Profile
Step 2
Energy Price + Adders
Step 2
T&D Charges (Demand Charges)
Step 2
StorageVET®
Step 3
New Customer Bill
Step 1
Distribution Analysis (Feeder)

Perfect Foresight vs. No Information Net Load Comparison

Example Day: 08/10/2016 (17:00 hrs to 18:00 hrs) (IESO's Peak Day)



Financial Analysis Assumptions

1. Utility is willing to provide financial compensation for capacity deferral service provided by behind-the-meter (BTM) storage

2. This financial compensation is set by the base case cost (reconductoring) (calculated to be **$78.2k/yr**)

3. Capacity deferral is still the primary control objective assigned to the storage system, despite being located BTM

4. **Stacked benefits:** When not providing capacity deferral (primary objective), storage owner dispatches storage to minimize demand charges (secondary objective)

Summary of Findings

(Assuming 2017 Storage Costs)	***Forecast information available to storage owner on top 5 peak hours***	
Net Present Worth (2016 $)	*No information*	*Perfect forecast*
Capacity deferral service is financially compensated at $78.2k/yr (Base Case Cost)	+$0.78M	+ $3.86M

Impact of better peak forecast →

- Financial Analysis shows that the project *already* breaks even when just relying on demand charge reductions (for both perfect foresight and no information cases)
- Assume that the utility is financially compensating the storage owner for the capacity deferral service at the levelized cost of reconductoring of **$78.2k/yr**

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