

Energy Storage Evaluation Tool™



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Background

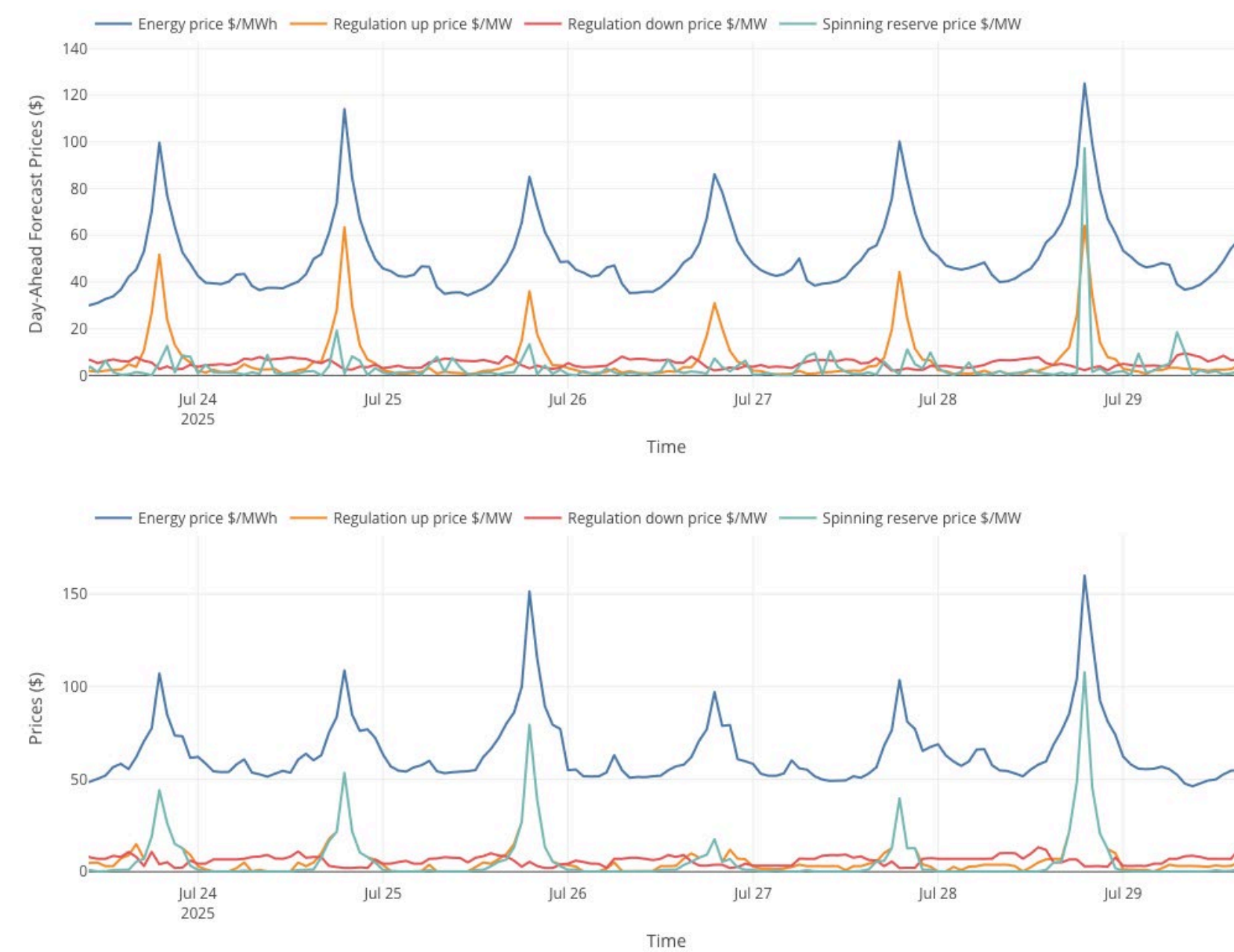
Built on models, datasets, and code from the first dozen or so storage assessment and deployment projects, ESET has evolved through application in over 60 projects and continued integration of new capabilities to meet emerging needs.

Comprehensive & Consistent Modeling

- Different storage technologies, hybrid or microgrid
- Technical characteristics and physical capabilities
- Appropriate levels of complexity and fidelity
- Grid and behind-the-meter services
- Distribution network models

Integrated Uncertainties and Control

- Account for Operational Uncertainties
 - Forecast Errors
 - Random Outages
- Ensure the Estimates Align with Actual Benefits



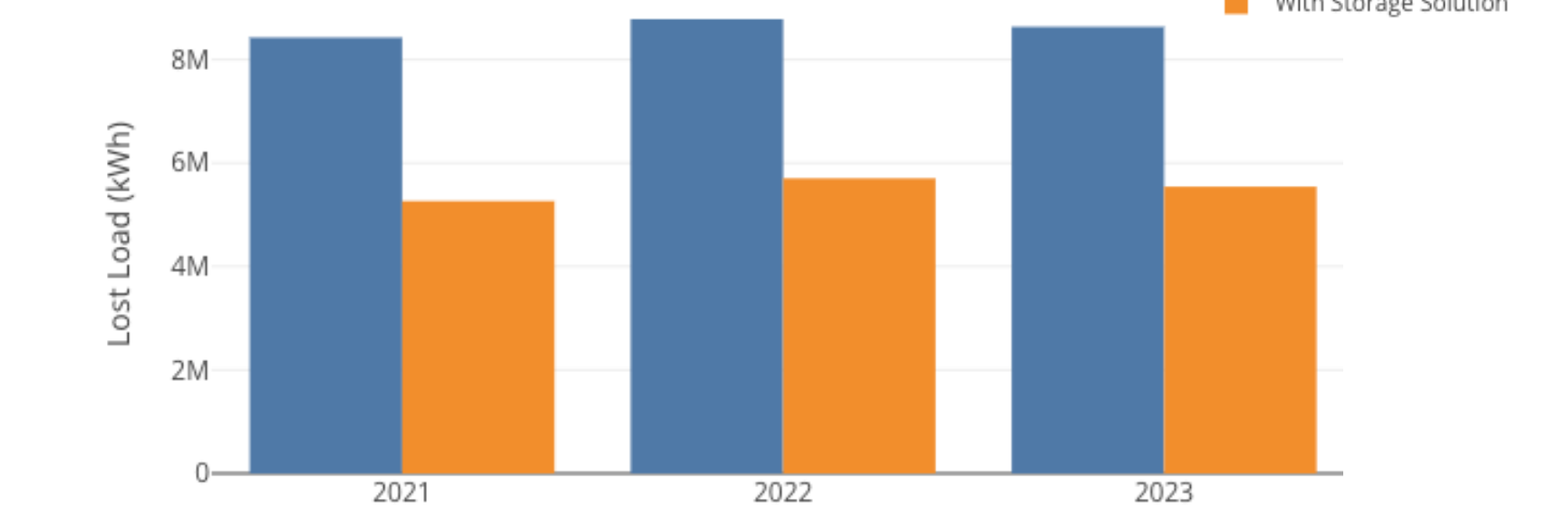
New App on Reliability and Resilience: ES4R2

- Customizable Resilience Metrics

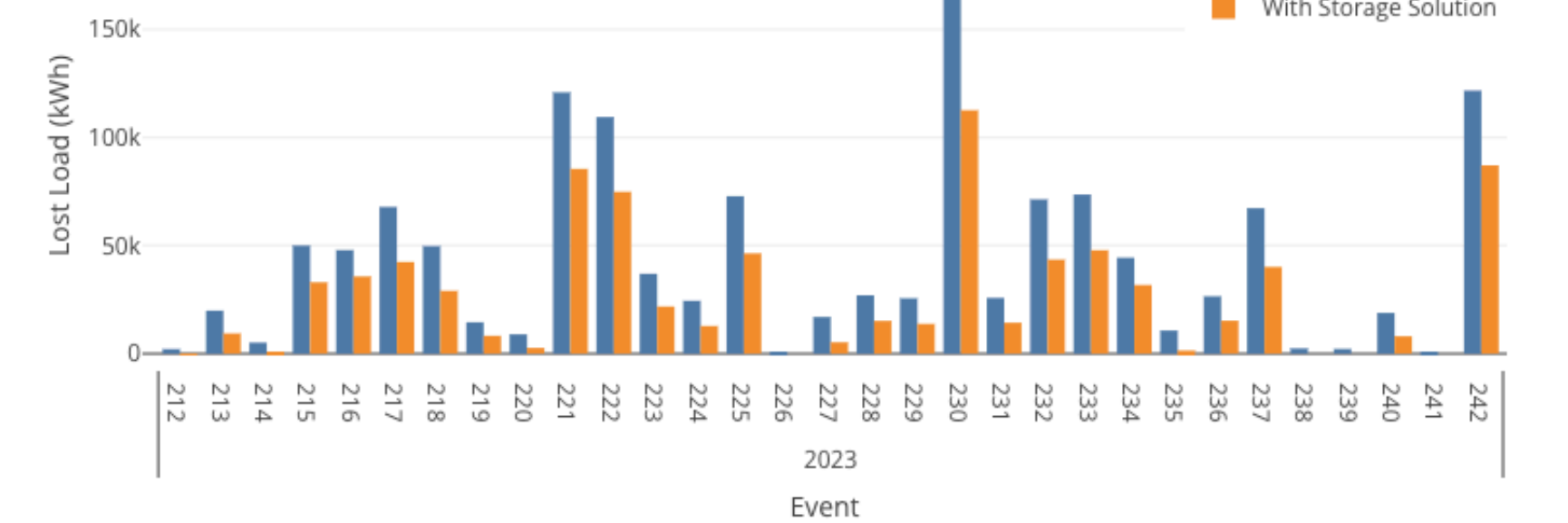
	Baseline	With Storage Solution	Improvement
Lost Load (MWh/year)	3.50	1.09	2.40 (69%)
Value of Lost Load (\$/year)	56K	14K	42K (74%)
Outage Duration (minutes/year)	224	106	119 (53%)
Outage Frequency (times/year)	2.7	1.2	1.5 (56%)

- Integrated Databases
 - Historical outage events
 - Electric service reliability
- Two Analysis Modes
 - Individually specified events (historical or synthetic)

Metric Comparisons By Year



Metric Comparisons By Event



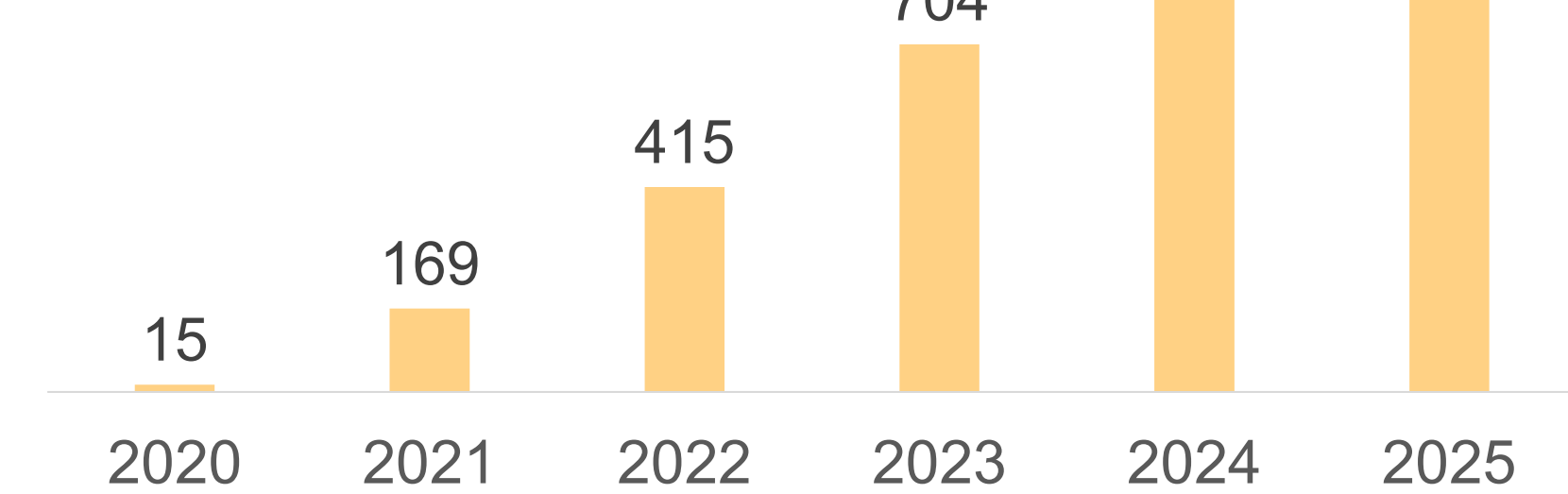
Platform Overview

A suite of applications that enable various stakeholders to **model, optimize, and evaluate** different types of energy storage systems for stacked value streams

- Battery Storage Evaluation Tool (BSET)
- Energy Storage for Resilience and Reliability (ES4R2)
- Microgrid Asset Sizing considering Cost and Resilience (MASCORE)
- Pumped-Storage Hydropower Evaluation Tool (PSHET)
- Hydrogen Energy Storage Evaluation Tool (HESET)
- Virtual Battery Assessment Tool (VBAT)
- Vehicle Grid Integration Evaluation Tool (VGIET)

1000+ Users

From 600+ Institutions



Key Features

Comprehensive Models

Consistent Modeling

Advanced Optimization

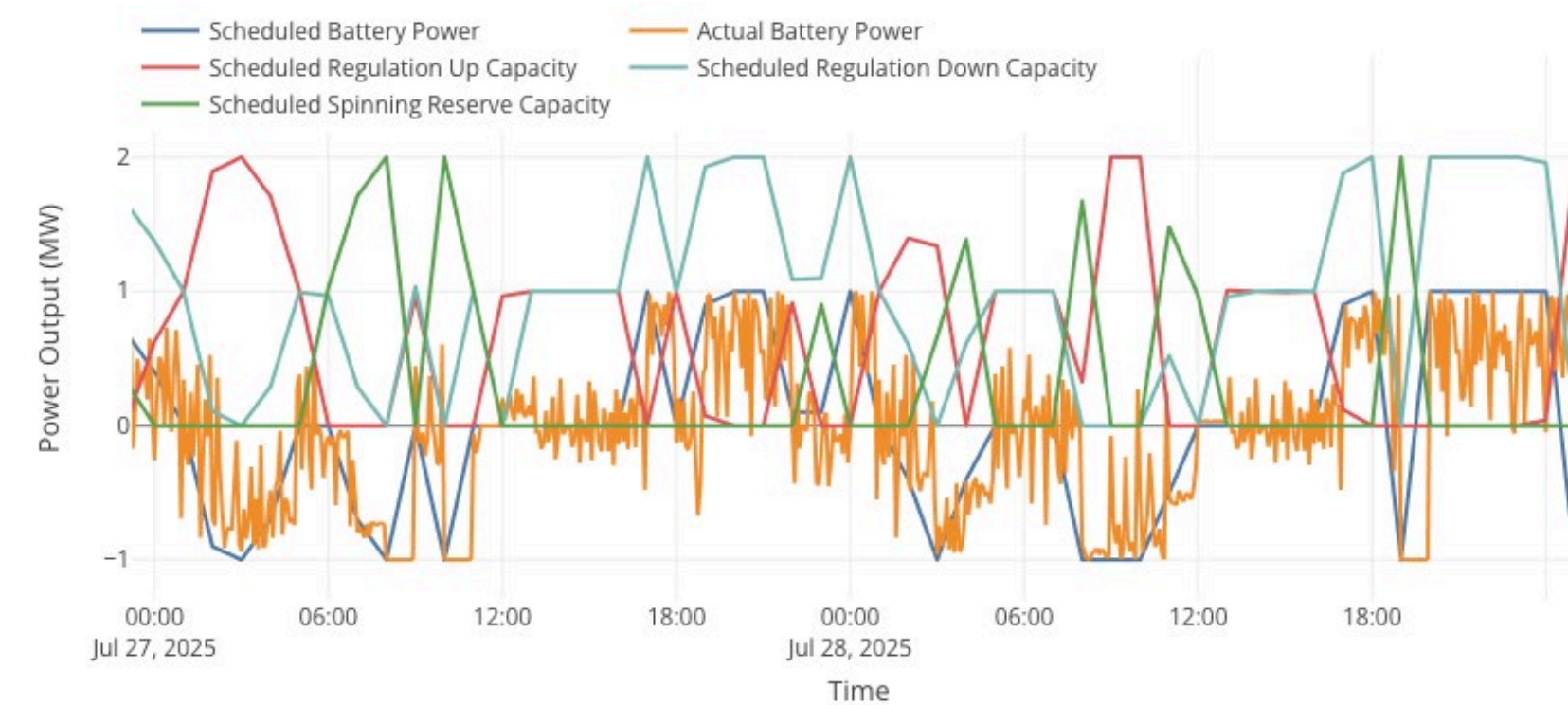
Built-in Database

Integrated Uncertainties

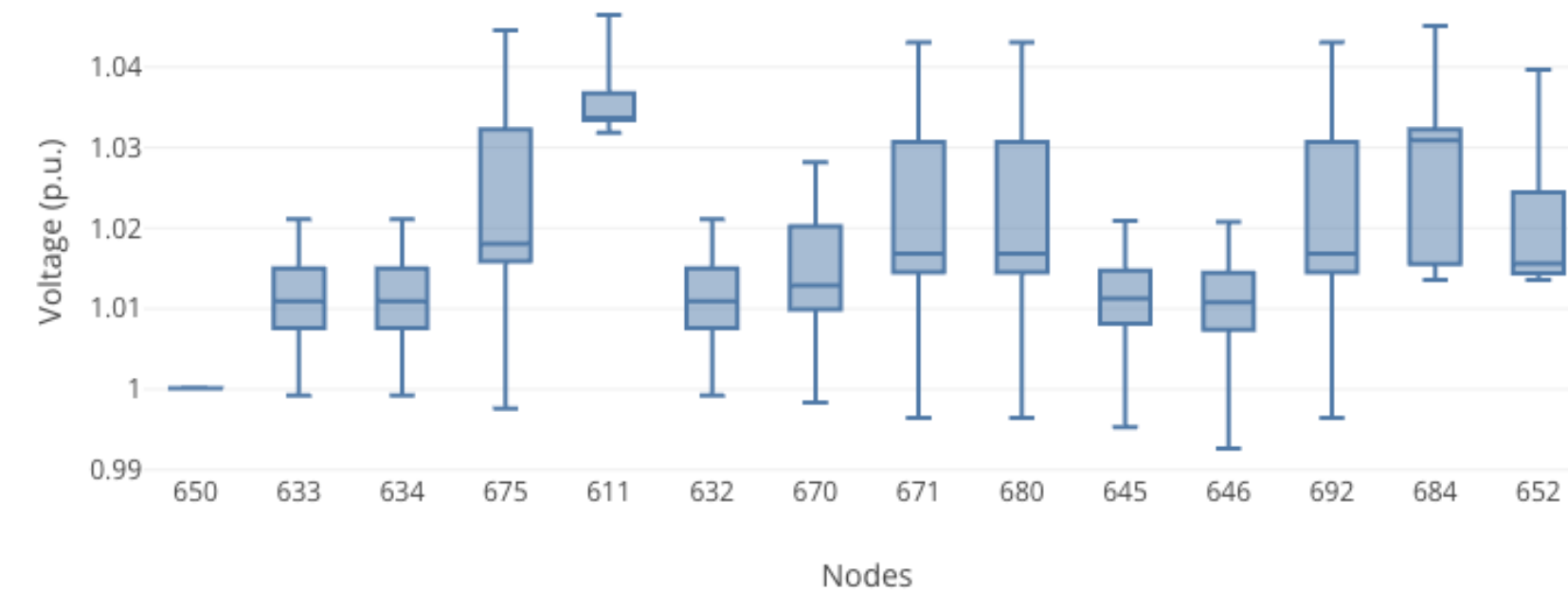
Dedicated Economic and Financial Analysis Engine

Advanced Optimization

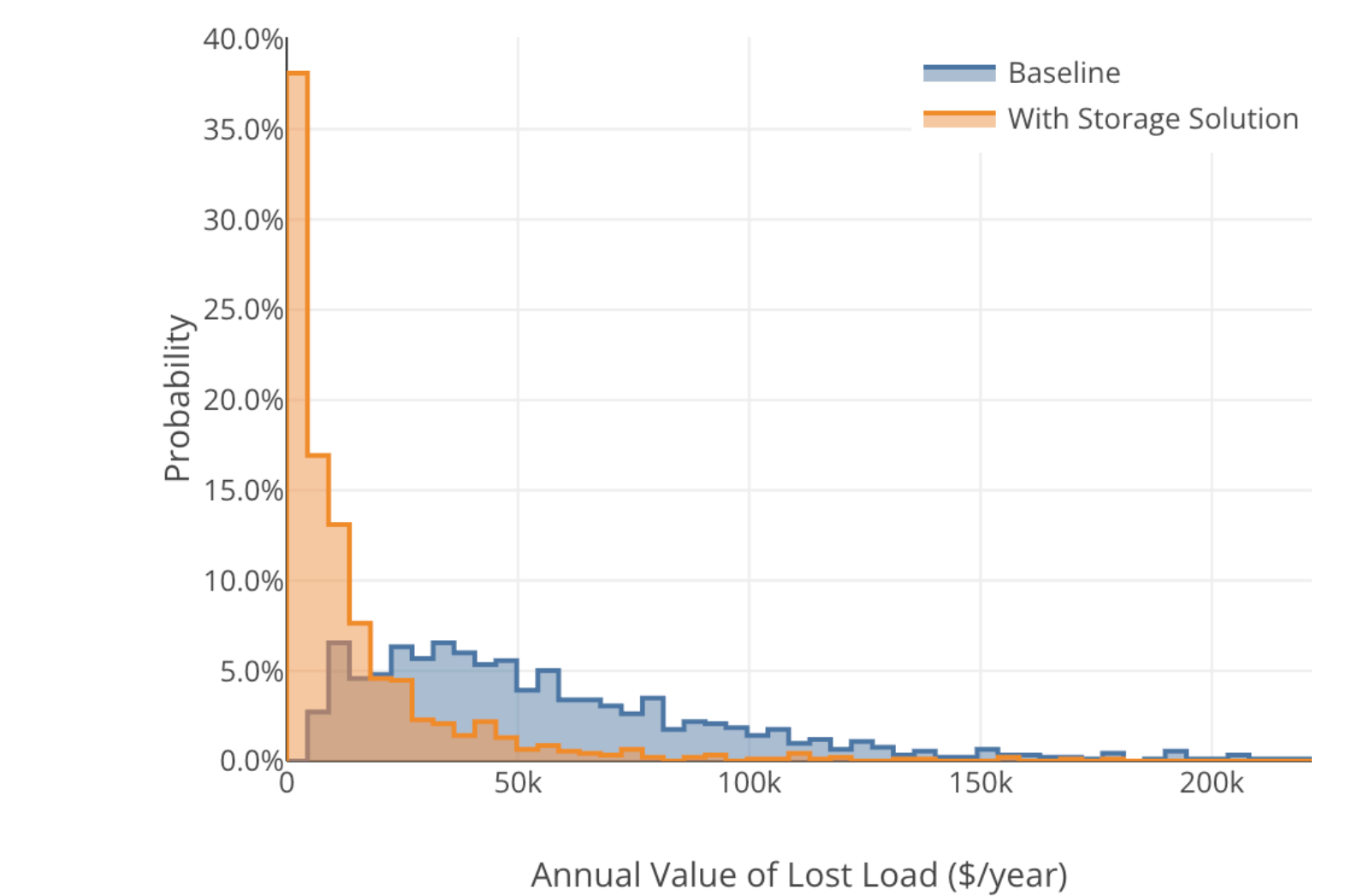
- Maximize Benefits from Stacked Value Streams
- Determine Optimal Sizing/Siting



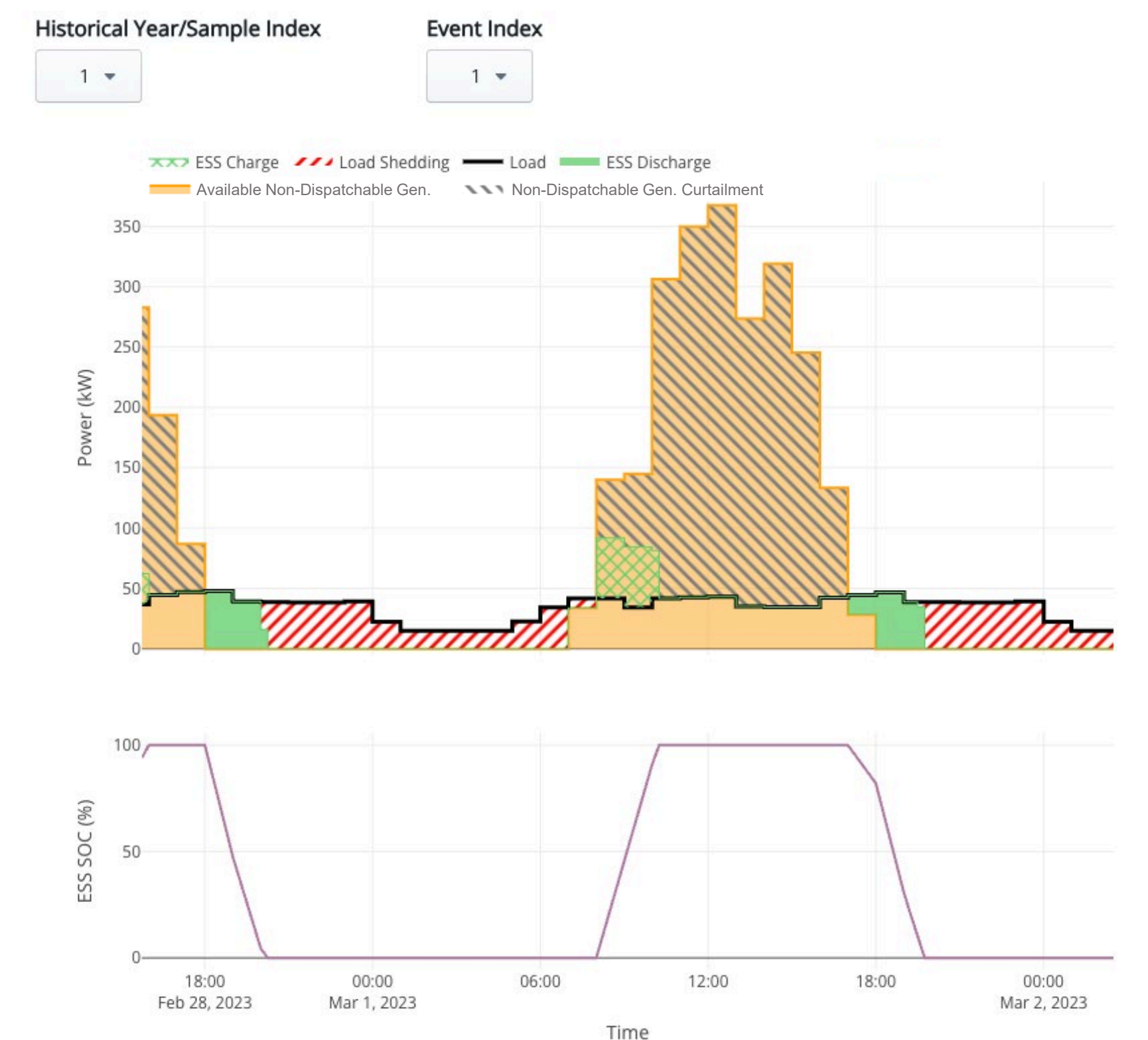
- Consider Multi-Dimensional Couplings
- Practical Constraints
 - Degradation and Operation Hour Limits
 - Voltage Violations and Line Flow Limits



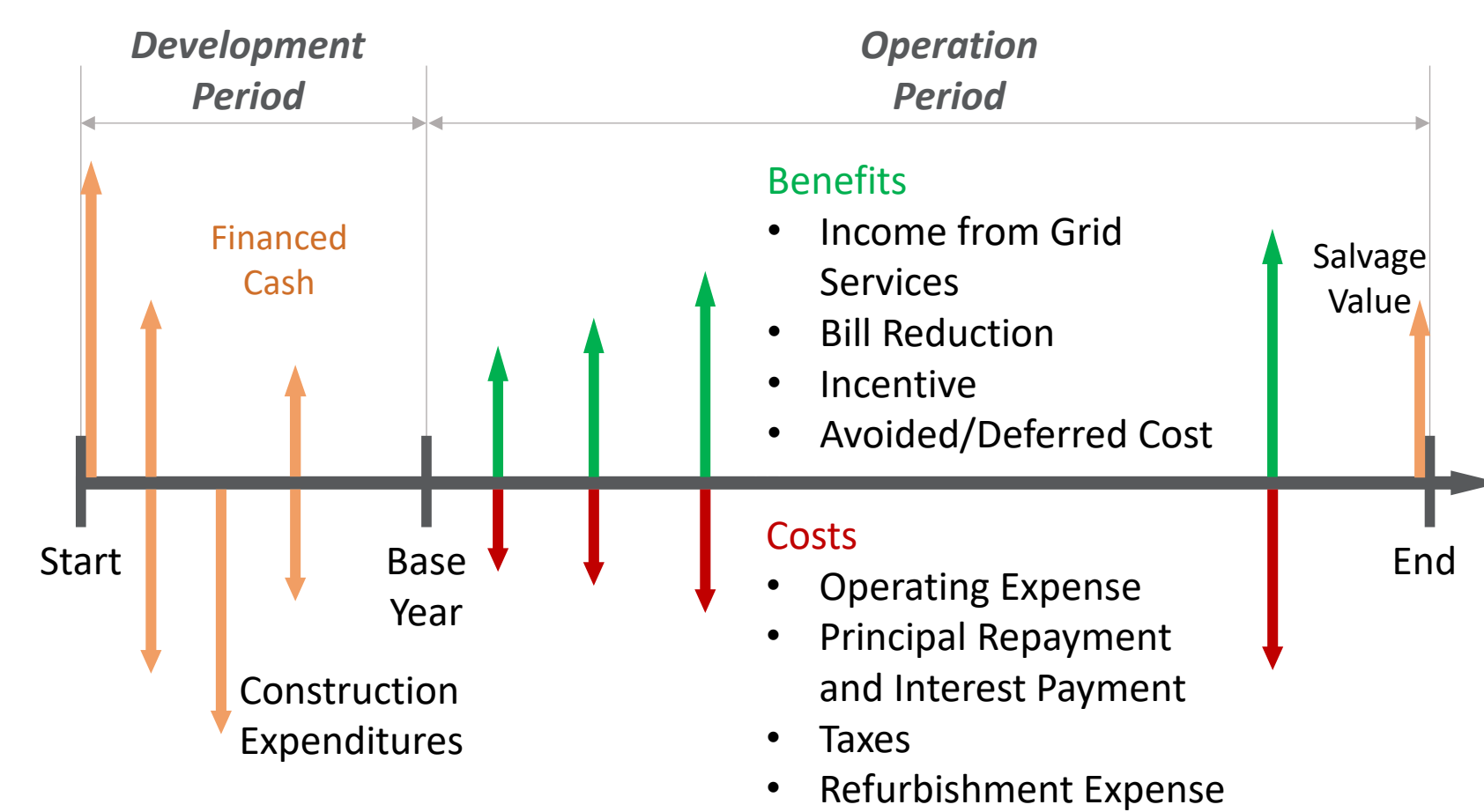
- Randomly generated outage events based on grid reliability metrics



- Detailed Operations in Up To Thousands of Events
 - Select from historical/simulated years
 - Inspect asset operations in each event



Economic and Financial Analysis Engine



- Results
 - Benefit-Cost Ratio, Net Present Value, Internal Rate of Return
 - Levelized Cost of Storage
 - Itemized PV Benefits and Costs
 - Net Income & Free Cash Flow

Integrated Databases

- Wholesale Market Prices
 - NYISO, ERCOT, SPP, ISO-NE, and CAISO
 - Energy – LMP
 - Ancillary services: regulation (up, down, and mileage), spin/non-spin reserve
- Utility Rate Structures
 - The Utility Rate Database (URDB) – 3,833 EIA-recognized utility companies
 - Energy and demand charges: flat, time-of-use, tiered
- Typical Building Load Profiles
 - Commercial and Residential Hourly Load Profiles for all TMY3 Locations in the United States developed by NREL
- Energy Storage Cost and Performance Database
- Reliability Metrics and Historical Outages
 - EIA-861 survey dataset
 - EAGLE-I database

