U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

REopt Lite Beta Version
Introduction to FEMP & NREL's New Web Tool

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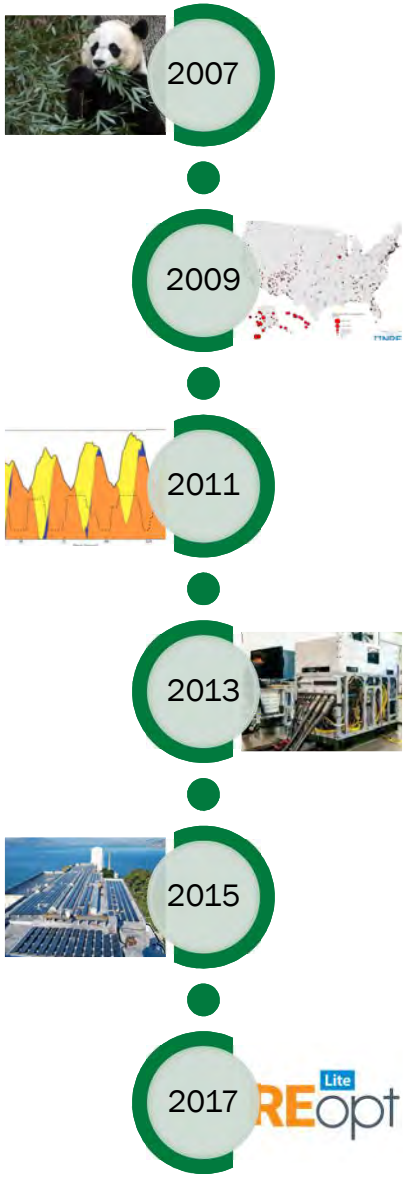
FEMP Federal Energy Management Program

The REopt Model and It's History

FEMP uses REopt to help agencies screen and evaluate renewable energy opportunities and focus resources on projects that have economic and technical viability.

REopt has been used to assess opportunities at over 10,000 sites, REopt analyses have supported decisions that led to more than 260 MW of renewable energy development.

- US Forest Service
- National Park Service
- Fish and Wildlife Service
- Department of Defense
- Department of Energy
- Department of Commerce
- Department of State
- General Services Administration
- US Department of Veteran's Affairs
- Department of Homeland Security
- US Department of Agriculture
- US Bureau of Reclamation
- Bureau of Land Management
- Indian Health Service
- Western Area Power Administration
- Navajo Generating Station



Developing the REopt Lite Web Tool

Mission

Provide access to a decision support tool for site-specific, optimized, and integrated analysis

Vision

Advance data-driven decision-making and deployment of renewable energy and energy storage technologies

REopt Lite: Sizing Solar+Storage for Savings and Resiliency

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November 15, 2017

[1]National Renewable Energy Laboratory [2] Federal Energy Management Program

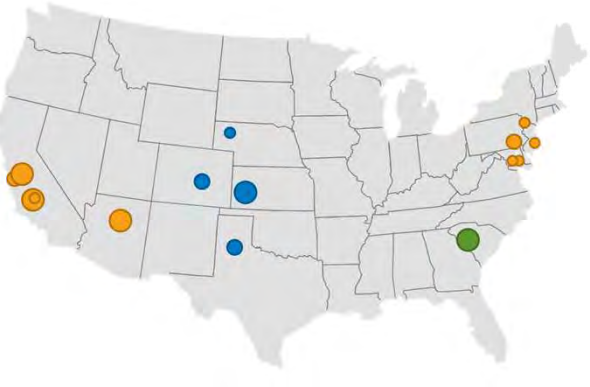
REopt: Decision Support Throughout the Energy Planning Process

REopt Integration and Optimization

Optimization • Integration • Automation

Master Planning

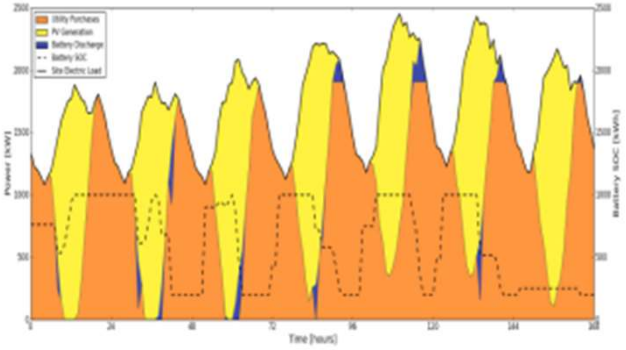
- Portfolio prioritization
- Cost to meet goals



Cost-effective RE at Army bases

Economic Dispatch

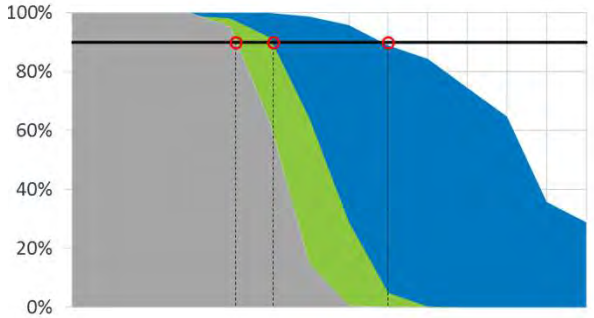
- Technology types & sizes
- Optimal operating strategies



Cost-optimal Operating Strategy

Resiliency Analysis

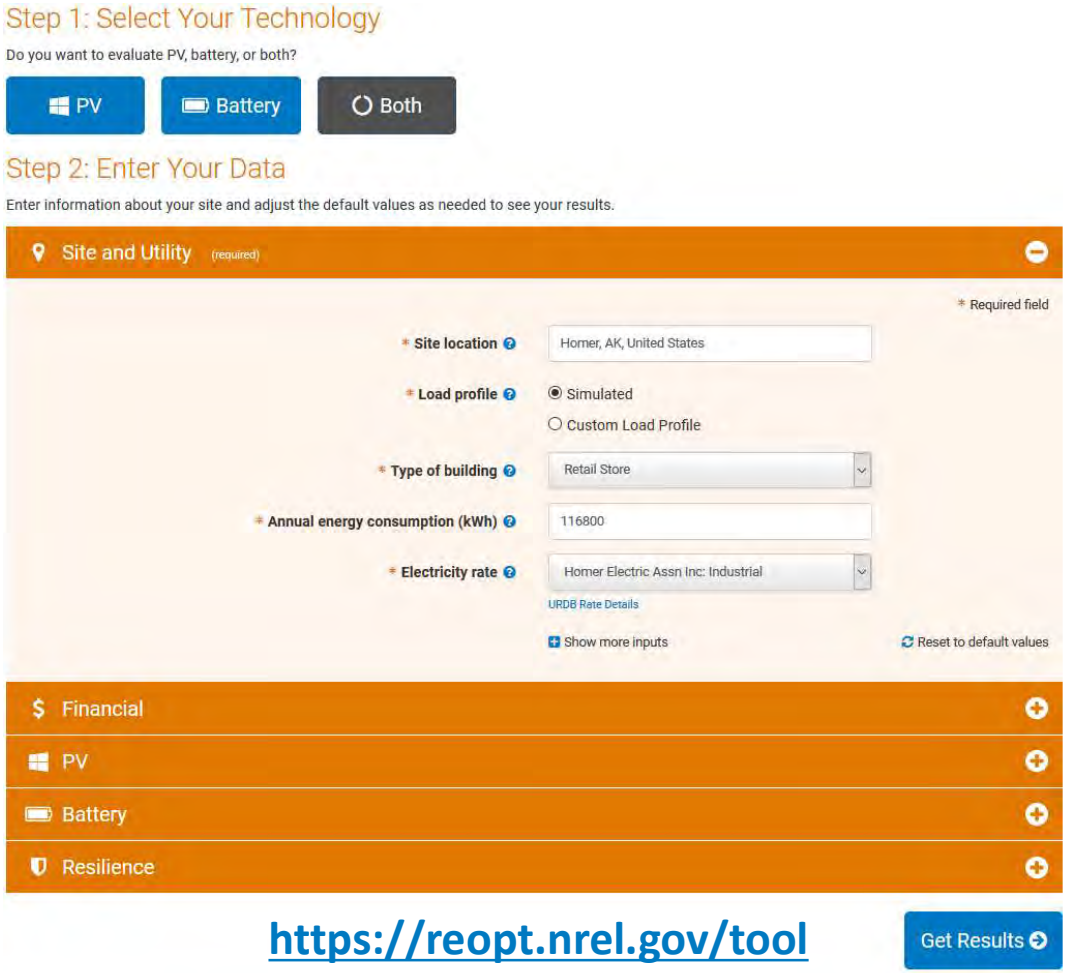
- Microgrid dispatch
- Energy security evaluation



Extending Resiliency with RE

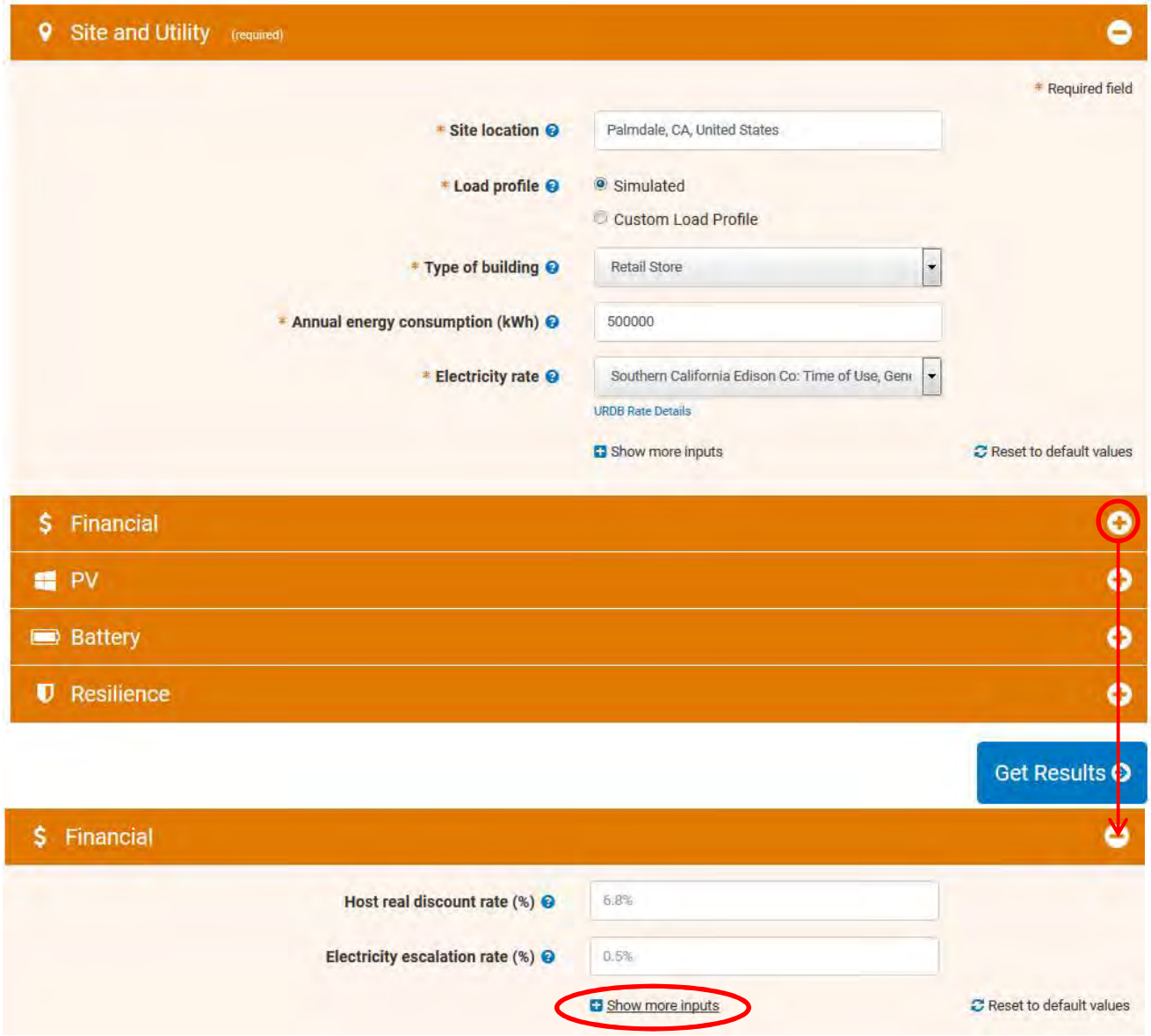
REopt Lite Web Tool

- Publicly available beta version of REopt Lite launched September 2017
- Evaluates the economics of grid-connected PV and battery storage at a site
- Allows building owners to identify the system sizes and battery dispatch strategy that minimize their life cycle cost of energy



https://reopt.nrel.gov/tool

Five Required Site Specific Inputs
Additional Inputs Can Be Edited, Or Left As Defaults



Summary Results Include System Sizes and Savings

Results for Your Site

These results from REopt Lite summarize the economic viability of PV and battery storage at your site. You can edit your inputs to see how changes to your energy strategies affect the results.

Edit Inputs

REopt Lite

Your recommended solar installation size

392 kW
PV size

Measured in kilowatts (kW) of direct current, this recommended size minimizes the life cycle cost of energy at your site.

Your recommended battery power and capacity

93 kW
battery power

342 kWh
battery capacity

This system size minimizes the life cycle cost of energy at your site. The battery power and capacity are optimized for economic performance.

Your potential life cycle savings (20 years)

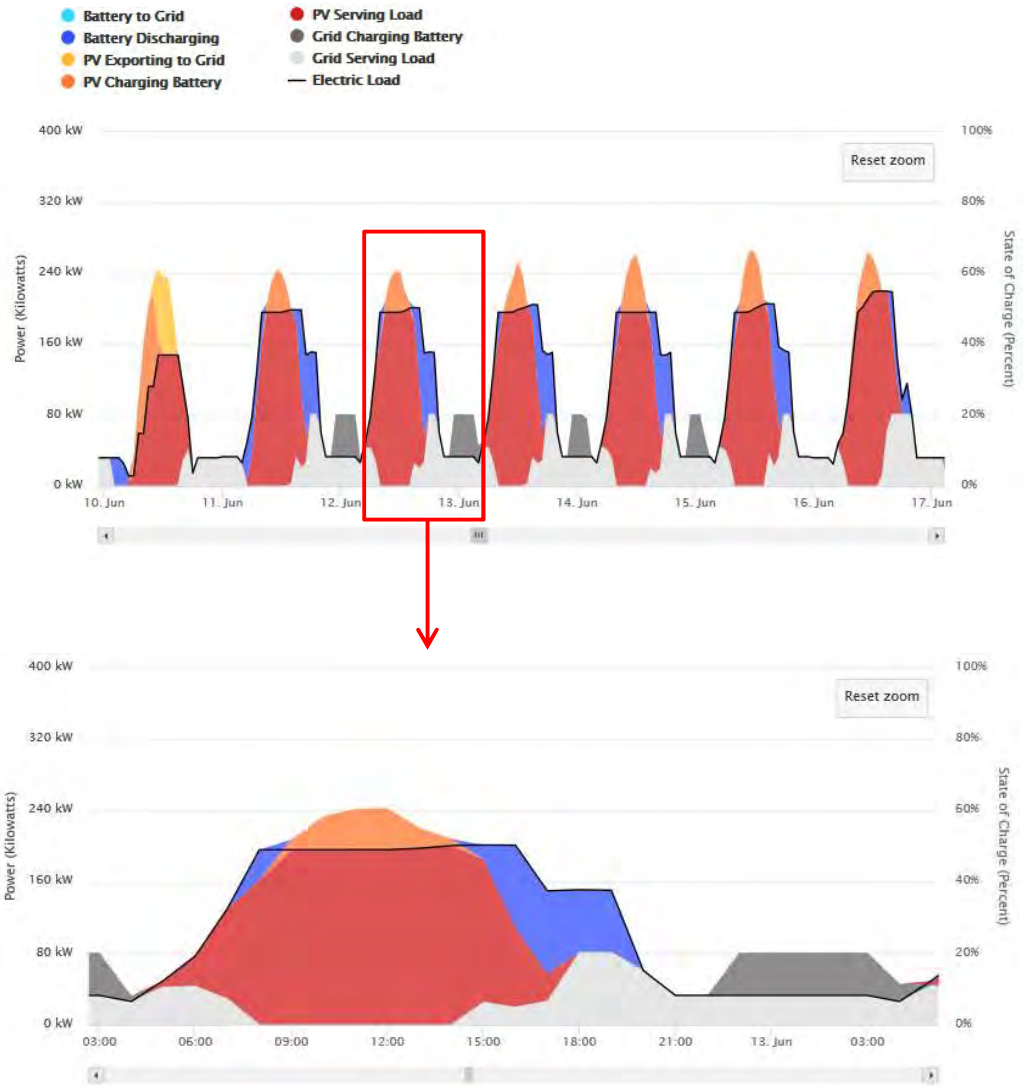
This is the net present value of the savings (or costs if negative) realized by the project based on the difference between the life cycle energy cost of doing business as usual compared to the optimal case.

$238,450

Additional Results Output
Economics Summary and Hourly Dispatch Graph

	Business As Usual	Optimal Case
System Size, Energy Production, and System Cost		
PV Size	0 kW	392 kW
Annualized PV Energy Production	0 kWh	680,826 kWh
Battery Power	0 kW	93 kW
Battery Capacity	0 kWh	342 kWh
DG System Cost (Net CAPEX + O&M)	$0	$526,342
Energy Supplied From Grid in Year 1	1,000,000 kWh	358,623 kWh
Year 1 Utility Cost — Before Tax		
Utility Energy Cost	$118,263	$34,216
Utility Demand Cost	$40,008	$18,623
Utility Fixed Cost	$3,110	$3,110
Utility Minimum Cost Adder	$0	$0
Life Cycle Utility Cost — After Tax		
Utility Energy Cost	$857,868	$248,200
Utility Demand Cost	$290,213	$135,089
Utility Fixed Cost	$22,562	$22,562
Utility Minimum Cost Adder	$0	$0
Total System and Life Cycle Utility Cost — After Tax		
Life Cycle Energy Cost	$1,170,644	$932,194
Net Present Value	$0	$238,450

Download ProForma Spreadsheet



FY18 REopt Lite Development Plan

REopt Integration and Optimization

Task	Description
API	Expose API and provide wiki to call model via API
Resiliency	Expand resiliency analysis • Build up a critical load profile based on equipment • Model existing diesel and PV systems • Design system based on probability of sustaining critical load • Incorporate the value of lost load
User data storage	Allow user to retrieve and edit stored inputs for future analysis
Wind	Add wind technology, purchase license for wind dataset
Custom utility rate	Allow user to enter custom utility rate tariff
Report	Downloadable sensitivity analysis report and dispatch strategy
User resources	Training materials and case studies

REopt Website
https://reopt.nrel.gov/

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NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Backup Slides

Resources

REopt Integration and Optimization

- REopt website: https://reopt.nrel.gov/
- REopt Lite web tool: https://reopt.nrel.gov/tool
- REopt technical report: https://www.nrel.gov/docs/fy17osti/70022.pdf
- REopt fact sheet: http://www.nrel.gov/docs/fy14osti/62320.pdf

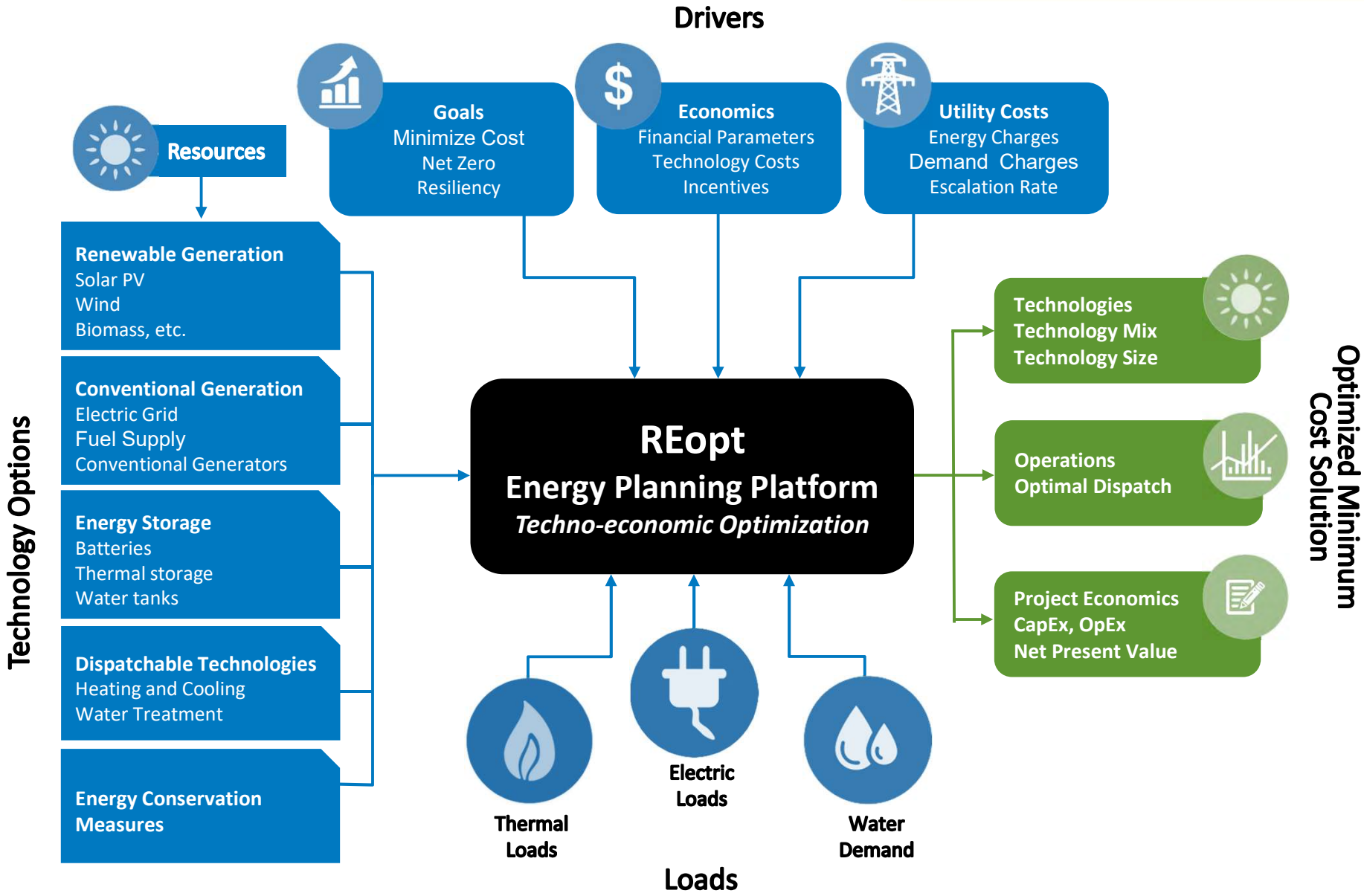
REopt Platform vs. Web Tool Phase 1 Capabilities

REopt Integration and Optimization

	Current Platform Capabilities	Phase 1 Web Tool Capabilities
Technologies Evaluated	PV, SHW, SVP, Wind, Biomass, LFG, WTE, GSHP, Storage, Conventional reciprocating and combustion turbine generators	PV + Storage
Sites Evaluated	Multi-site	Single site
Load Types	Electric, thermal, interval data from actual load profiles or simulated from DOE commercial reference buildings, others for customized analysis	Electric only interval data or simulated from DOE commercial reference buildings
Rate Tariffs	Blended rates, simple rate tariffs, and custom rates entered by user	Rate tariffs selected from URDB
Resiliency Analysis	Simple outage analysis or complex stochastic outage modeling	Simple outage analysis

REopt Inputs and Output

REopt Integration and Optimization

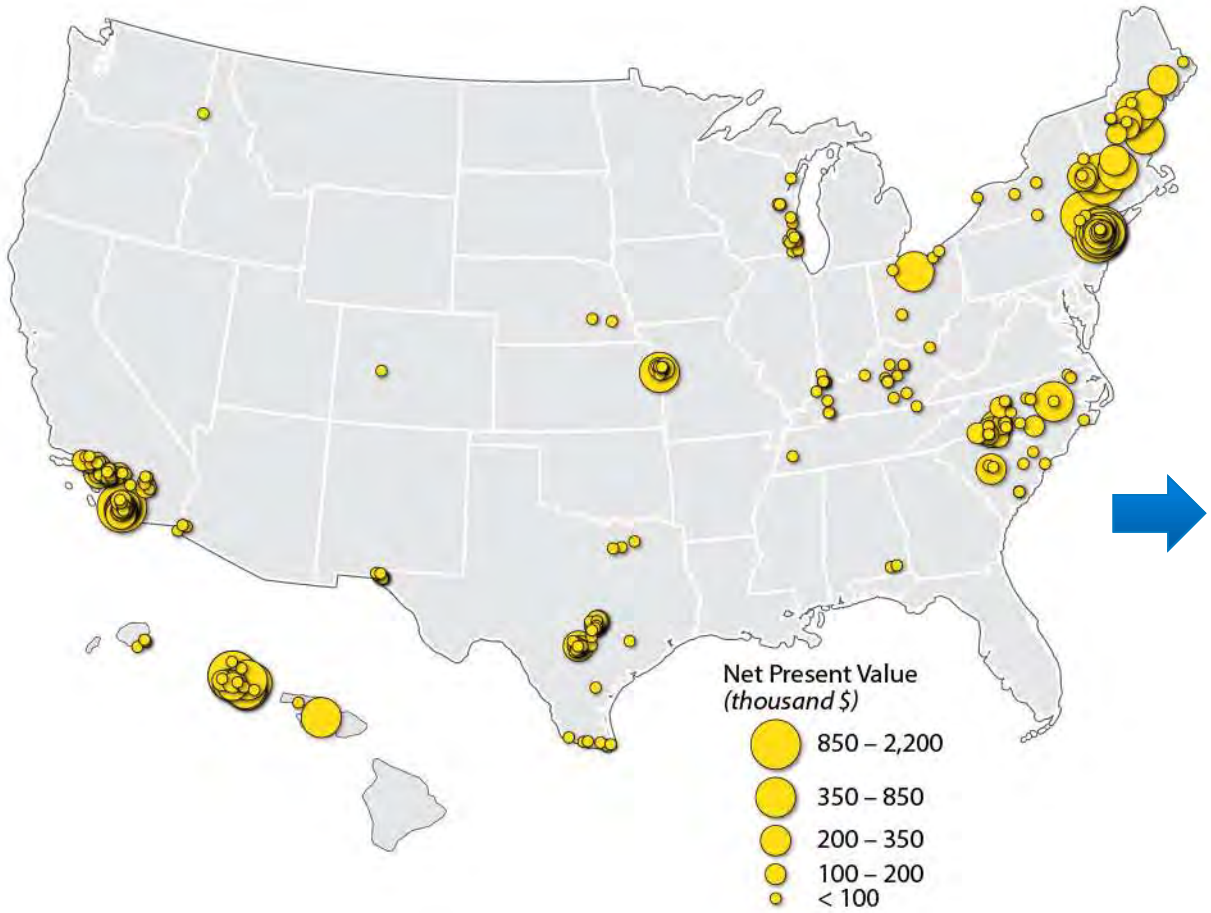


Project Example: Identifying & Prioritizing Projects across a Portfolio

REopt Integration and Optimization

REopt portfolio screening can help:

- Identify & prioritize cost-effective projects to minimize lifecycle cost of energy or achieve net zero
- Estimate cost of meeting renewable energy goals

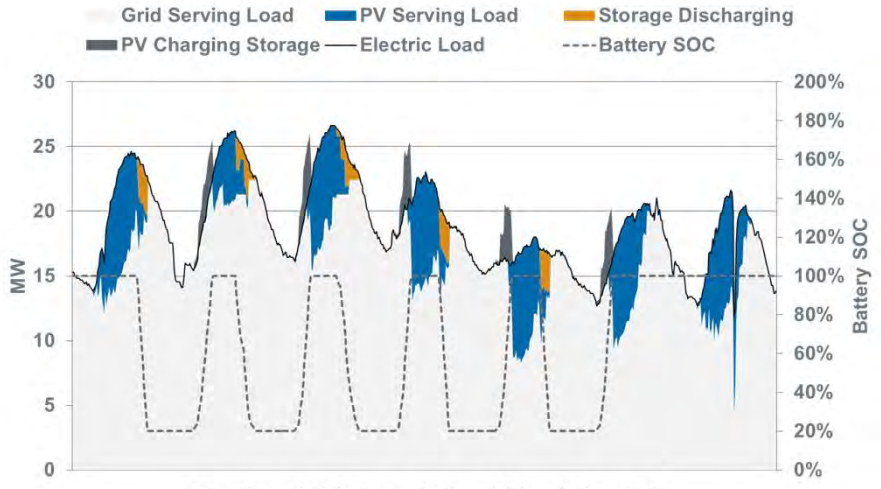


Sites Evaluated	696
Cost-Effective PV	306
Size	38.79 MW
NPV	$37 million
RE Generation	64.7 GWh
RE Penetration	10.5 %

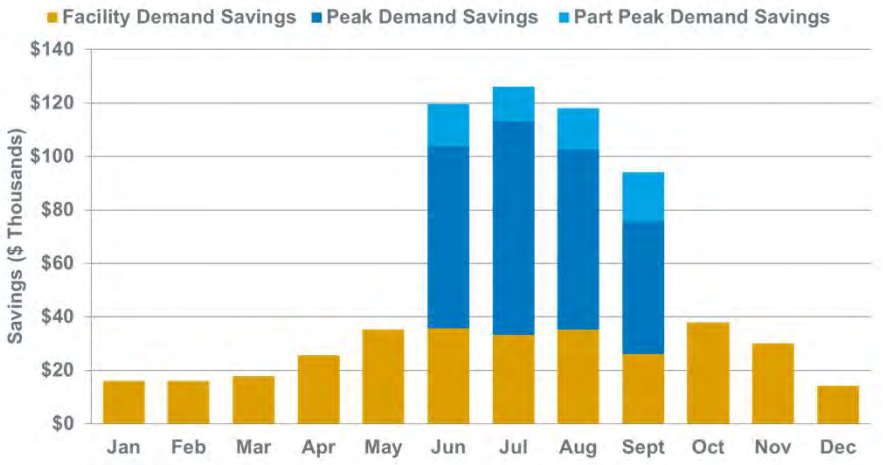
Project Example: PV + Battery Sizing

REopt Integration and Optimization

- Determine economically optimal PV + storage system size & dispatch using:
  - 15-minute electric load
  - Southern California Edison utility tariff TOU-8
- Results show 12.4 MW PV + 2.4 MW:3.7 MWh storage can provide $19.3 million NPV
- Battery is only economical when paired with PV at this site due to wide peaks
- Optimal battery dispatch strategy reduces all three demand charges



Optimal Dispatch for Week in July



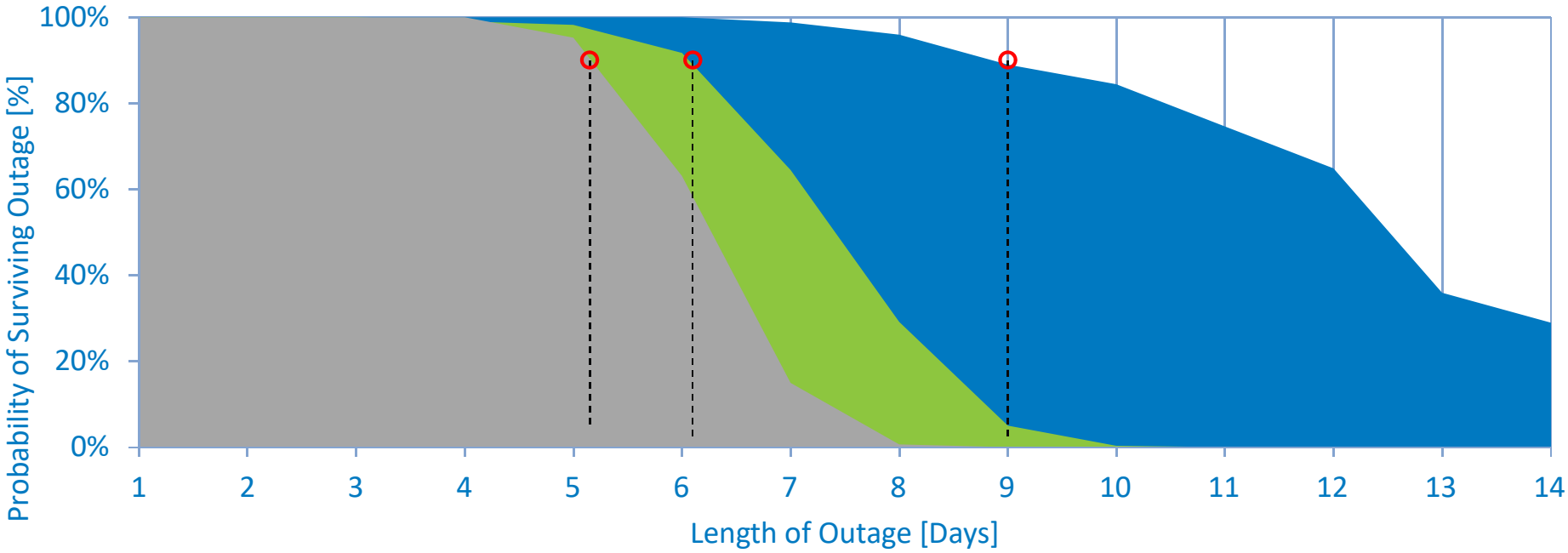
Savings from Demand Reduction

Project Example: Extending Survivability

REopt Integration and Optimization

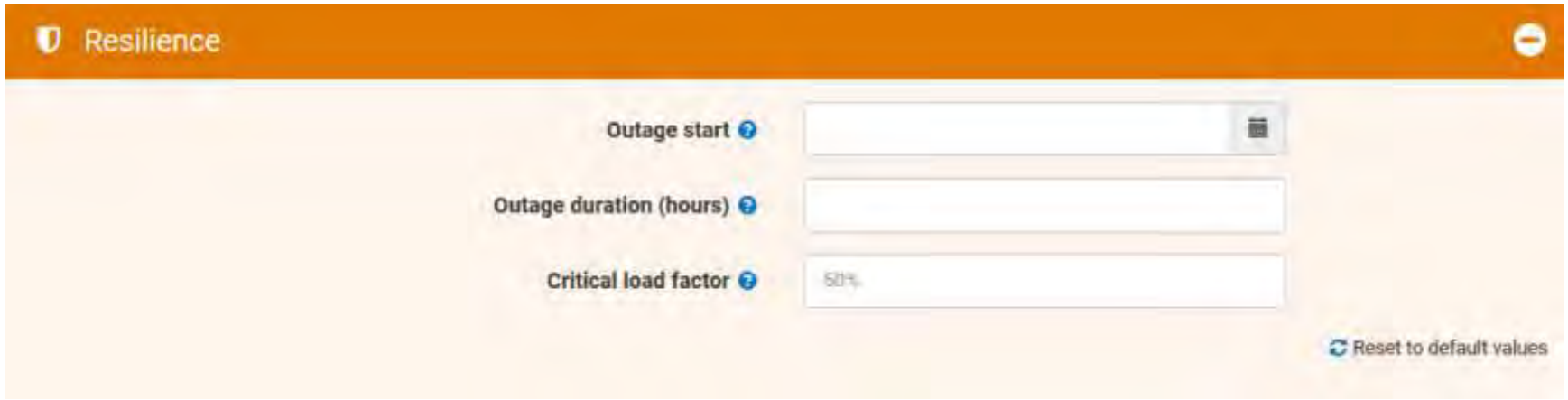
NREL evaluated thousands of random grid outages and durations throughout the year and compared number of hours the site could survive with a diesel generator and fixed fuel supply vs. generator augmented with PV and battery

	Generator	Solar PV	Storage	Lifecycle Cost	Outage
1. Base case	2.5 MW	-	-	$20 million	5 days
2. Lowest cost solution	2.5 MW	625 kW	175 kWh	$19.5 million	6 days
3. Proposed system	2.5 MW	2 MW	500 kWh	$20 .1million	9 days



Simple Resiliency Evaluation

Simple Resiliency Inputs



Simple Resiliency Outputs

Evaluate the amount of time that your system can survive grid outages.

	Business As Usual	Optimal Case	Difference
Average Resiliency (hours)	0 hours	3 hours	3 hours
Minimum Resiliency (hours)	0 hours	0 hours	0 hours
Maximum Resiliency (hours)	0 hours	21 hours	21 hours