REopt: Energy Decision Analysis
Overview for NCSP+ States Collaborative

Kathleen Krah
NREL
April 22, 2025

This presentation was produced when the laboratory operated as the National Renewable Energy Laboratory (NREL). The laboratory is now the National Laboratory of the Rockies (NLR).

Agenda

1. Welcome and Introductions (5 min.)
2. REopt Overview (15 min.)
3. REopt Web Tool Demo (10 min.)
4. Resources and Q&A (10 min.)

Will Distributed Energy Resources (DERs) Work for Your Site?

Local Energy Resource

Technology Costs and Incentives

Energy Goals

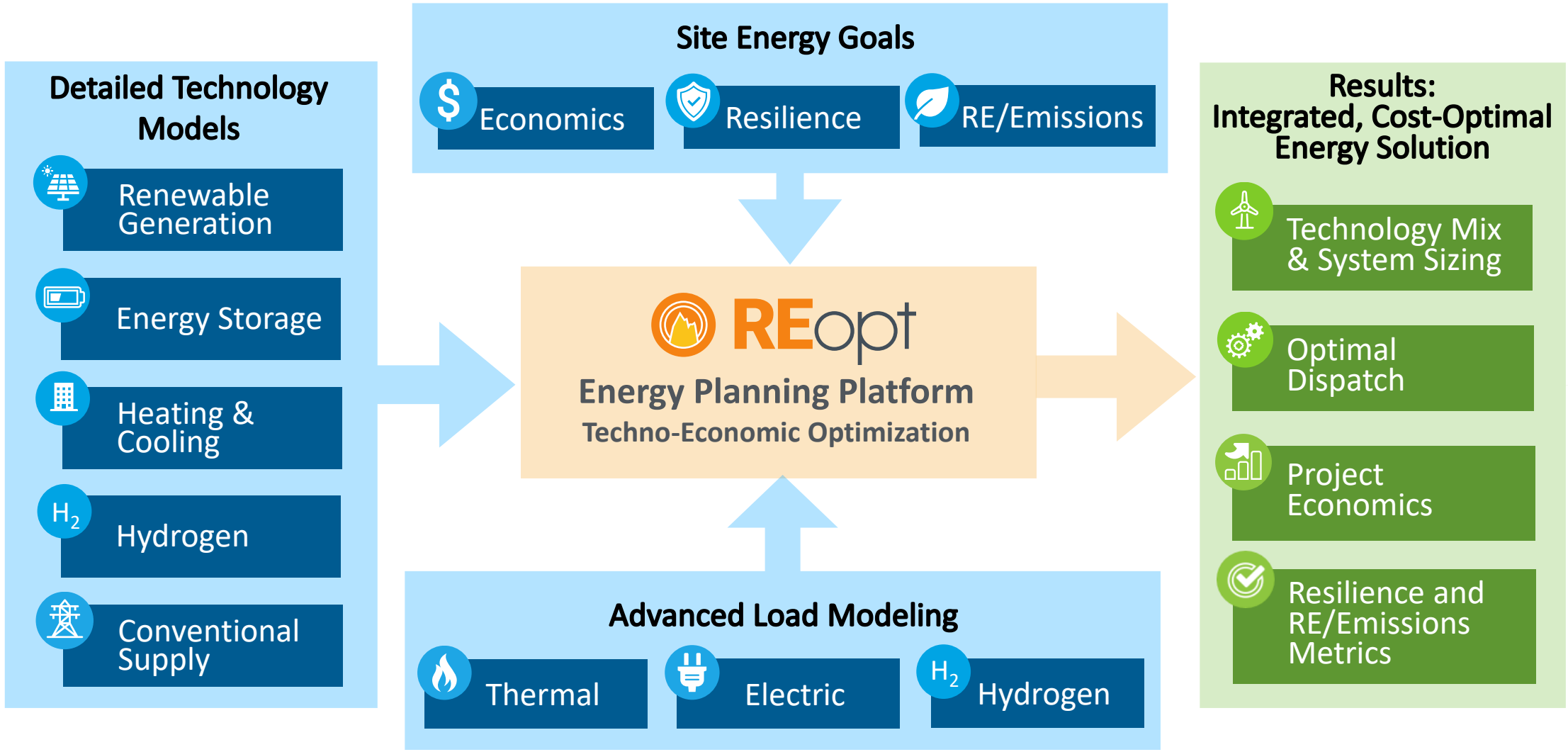
Utility Cost and Consumption

Financial Parameters

Many factors affect how DERs may provide cost savings and resilience to your site. REopt allows these factors to be evaluated concurrently.

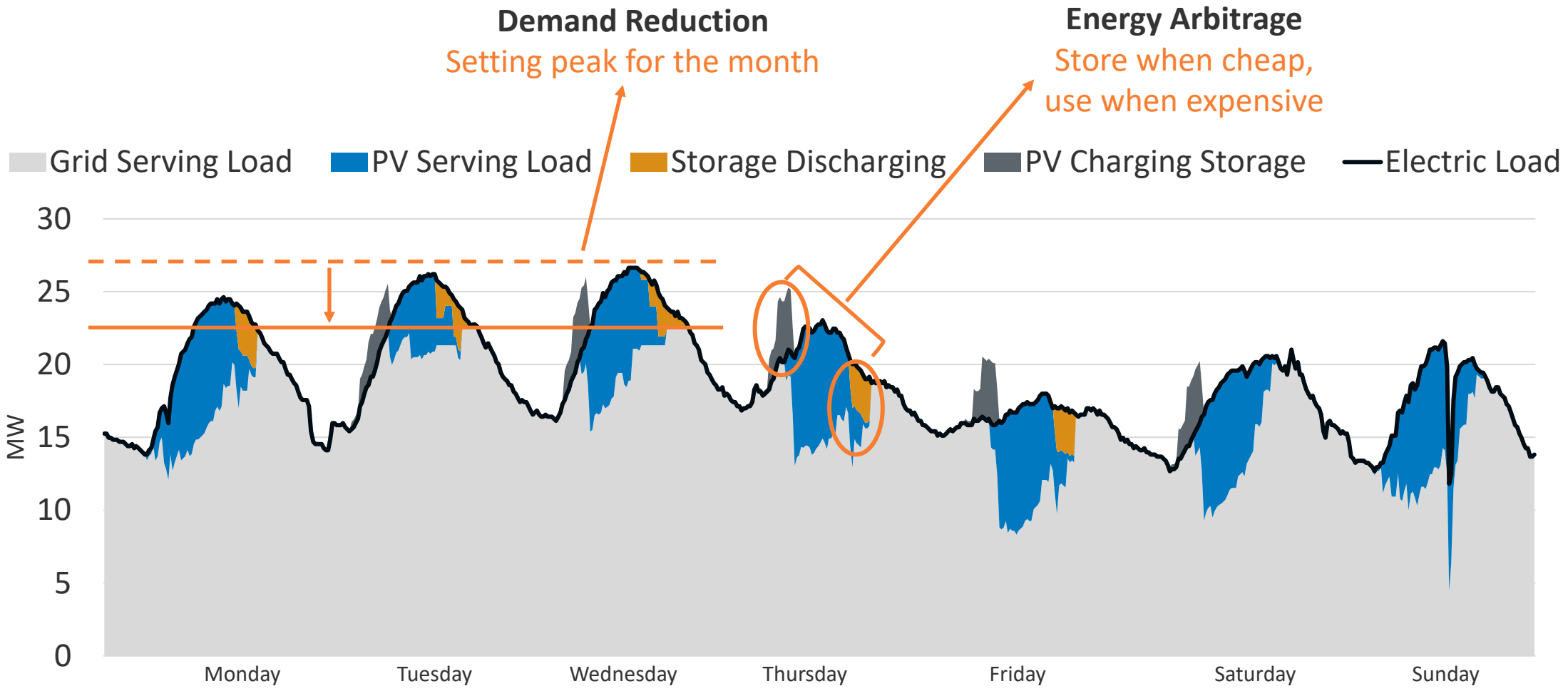
REopt Energy Planning Platform

Formulated as a mixed integer linear program, REopt provides an integrated, cost-optimal energy solution.



How Does REopt Work?

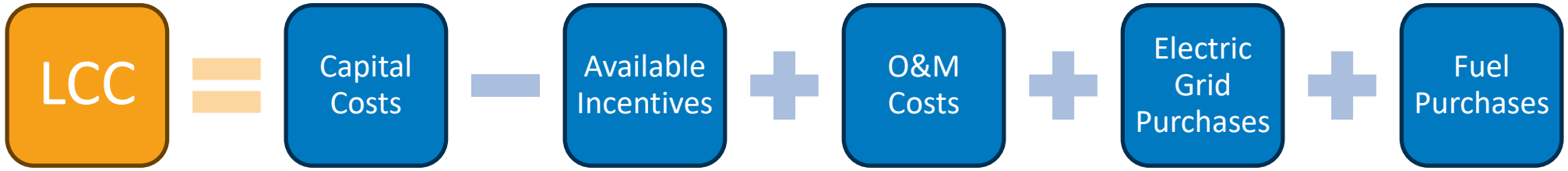
REopt considers the trade-off between ownership costs and savings across multiple value streams to recommend optimal size and dispatch.



Example of optimal dispatch of photovoltaics (PV) and a battery energy storage system (BESS)

REopt Minimizes the Life Cycle Cost of Energy

- **Life cycle cost (LCC)** of energy: The present value of all costs of energy at the site throughout the analysis period.



- **Net present value (NPV)** of DER system: The life cycle cost savings (difference in LCC) between the business-as-usual (BAU) case and the optimized (OPT) case.

If NPV > 0, the project provides cost savings relative to the BAU case.

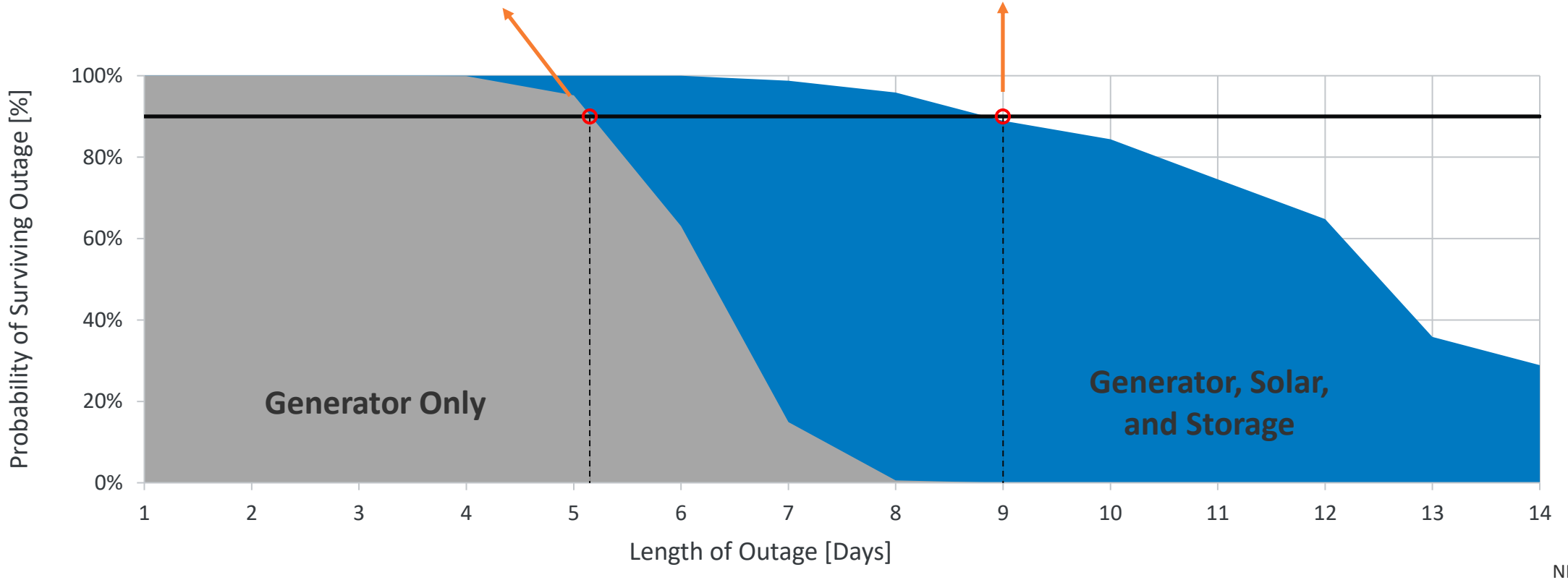
If NPV < 0, the project is more expensive than the BAU case.

How Does REopt Evaluate Resilience?

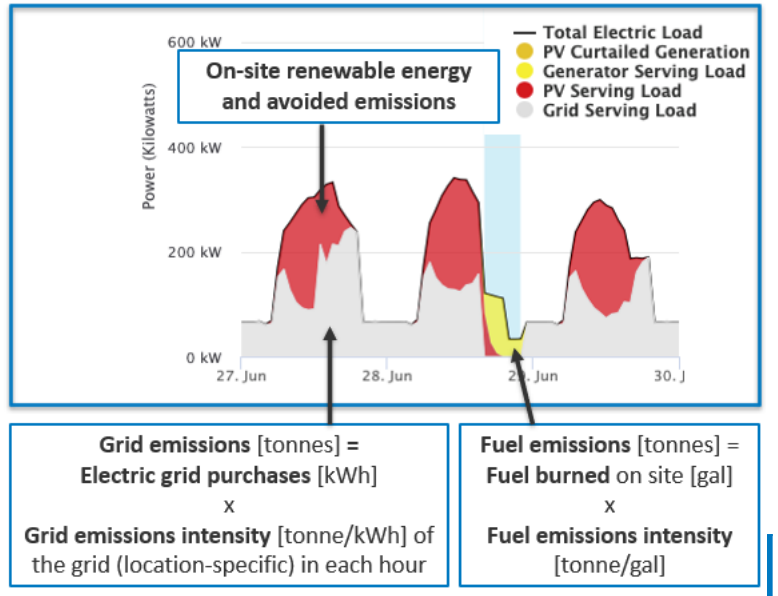
REopt identifies the system size and dispatch that minimizes life cycle energy costs for grid-connected operations and survives specified grid outage(s). It then evaluates thousands of random grid outage occurrences and durations to identify the probability of survival.

Existing generator with fixed fuel supply sustains the critical load for 5 days with 90% probability.

Adding solar and storage to the existing generator increases survivability from 5 to 9 days by extending fixed diesel fuel supplies and provides utility cost savings while grid-connected.



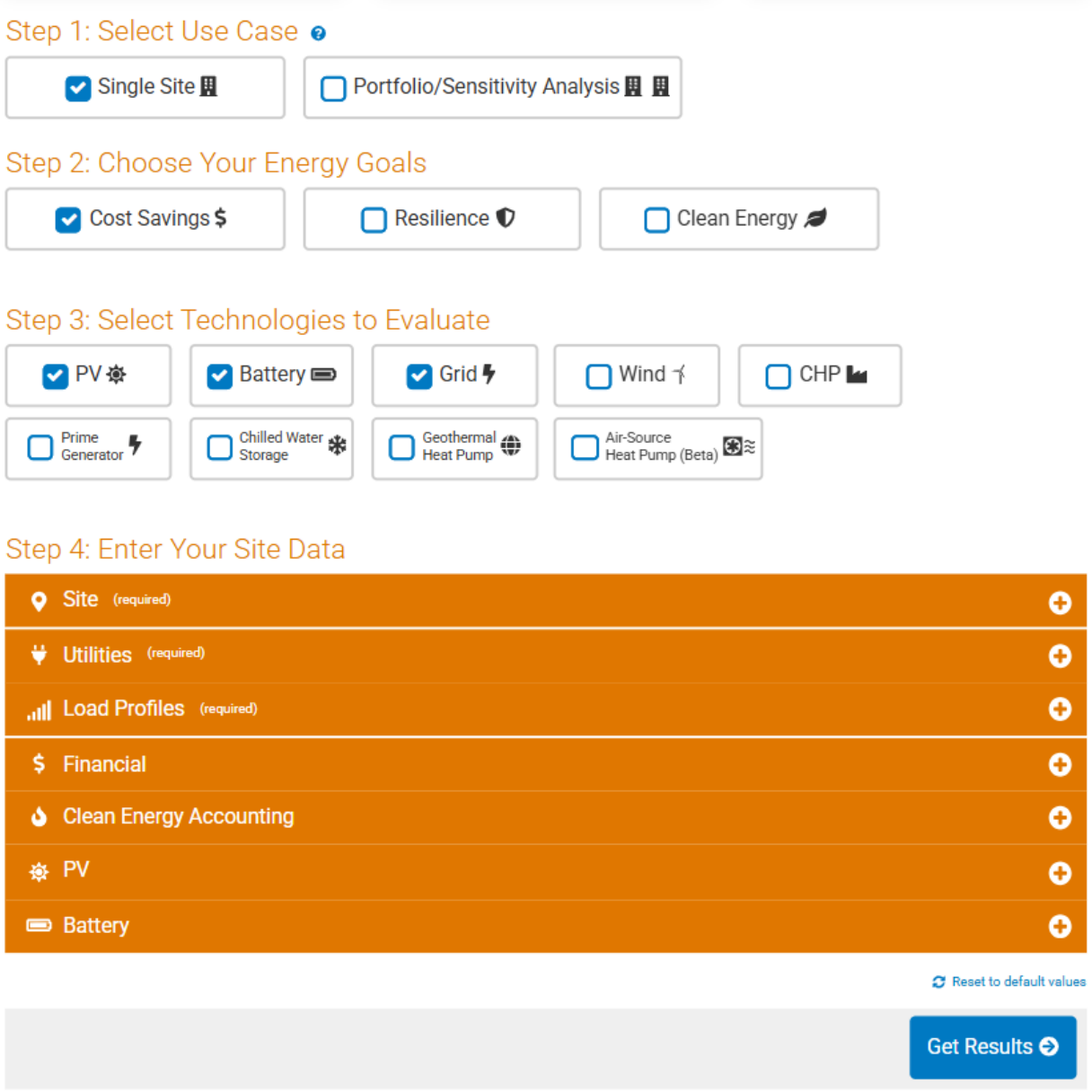
Renewable Energy & Emissions Accounting & Goals in REopt



Capability	Questions Answered
Renewable energy & emissions accounting *Included in all REopt evaluations*	• How much **renewable energy** does the DER system provide? • What are the **climate** and **health emissions** and **emissions cost** impacts of DER systems?
Percent on-site renewable electricity target *Optional*	• How do I achieve **x% on-site renewable electricity** (annually) at my site at the lowest life cycle costs?
Climate emissions reduction target *Optional*	• How do I **reduce my site's CO_2 emissions by x%** with DERs, relative to the BAU scenario? • What is the **break-even $/tonne CO_2** cost of CO_2 (or value of CO_2 reduction) to achieve this goal?
Climate and/or health emissions costs included in optimization *Optional*	• How does the cost-optimal system change if I consider the **$/tonne** costs of climate (CO_2) and/or health ($PM_{2.5}$, NO_x, SO_2) emissions?

REopt Web Tool User Interface

- **REopt web tool** provides free, publicly available, user-friendly capabilities from NREL's comprehensive **open-source REopt model.**
- Optimizes DER **system sizes** and **dispatch** strategies to **minimize life cycle cost of energy**
- Optional **resilience goals** can optimize DER systems to sustain critical load during grid outages.
- Optional **renewable energy and emissions reduction goals** can consider renewable energy and emissions reductions targets.
- Access the REopt web tool at reopt.nrel.gov.



REopt Web Tool Key Outputs

Your recommended solar installation size

3,885 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

276 kW
battery power

598 kWh
battery capacity

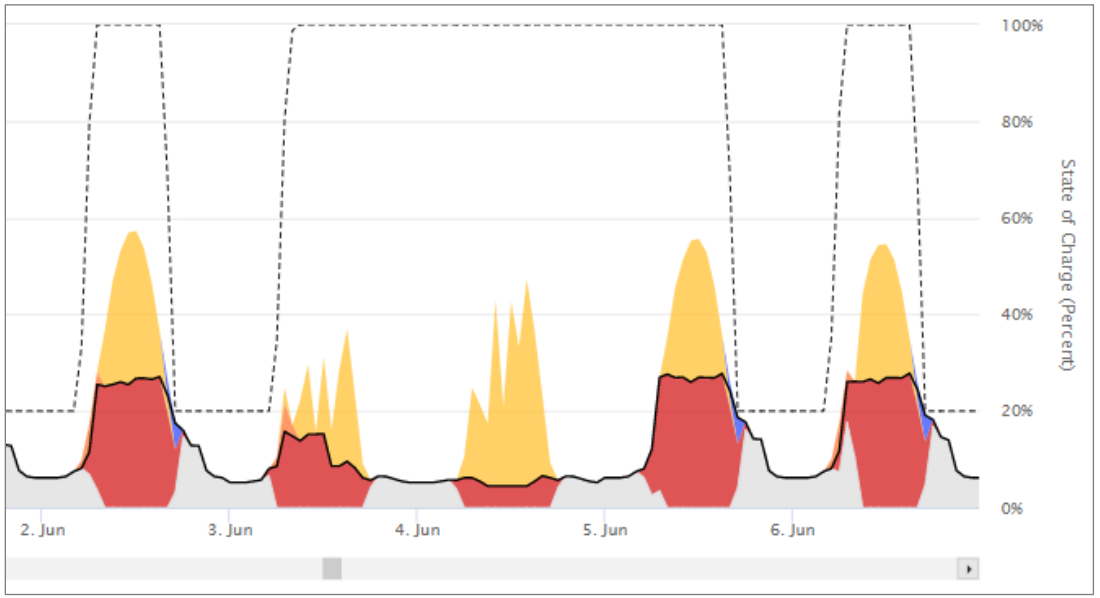
This system size minimizes the life cycle cost of energy at your site. The battery power and capacity are optimized for economic performance.

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 total life cycle costs of doing business as usual compared to the optimal case.

$1,972,493

System Size and NPV



Hourly Dispatch

	Business As Usual	Financial	Difference
Renewable Energy			
Annual Renewable Electricity (% of electricity consumption)	0%	58%	58%
Climate & Health Emissions Costs			
Cost of Climate Emissions throughout Analysis Period	$651,584	$273,948	-$377,636
Cost of Health Emissions throughout Analysis Period	$92,811	$39,485	-$53,326
Climate Emissions, CO_2			
Total Year 1 Emissions (t CO_2)	757	318	-439

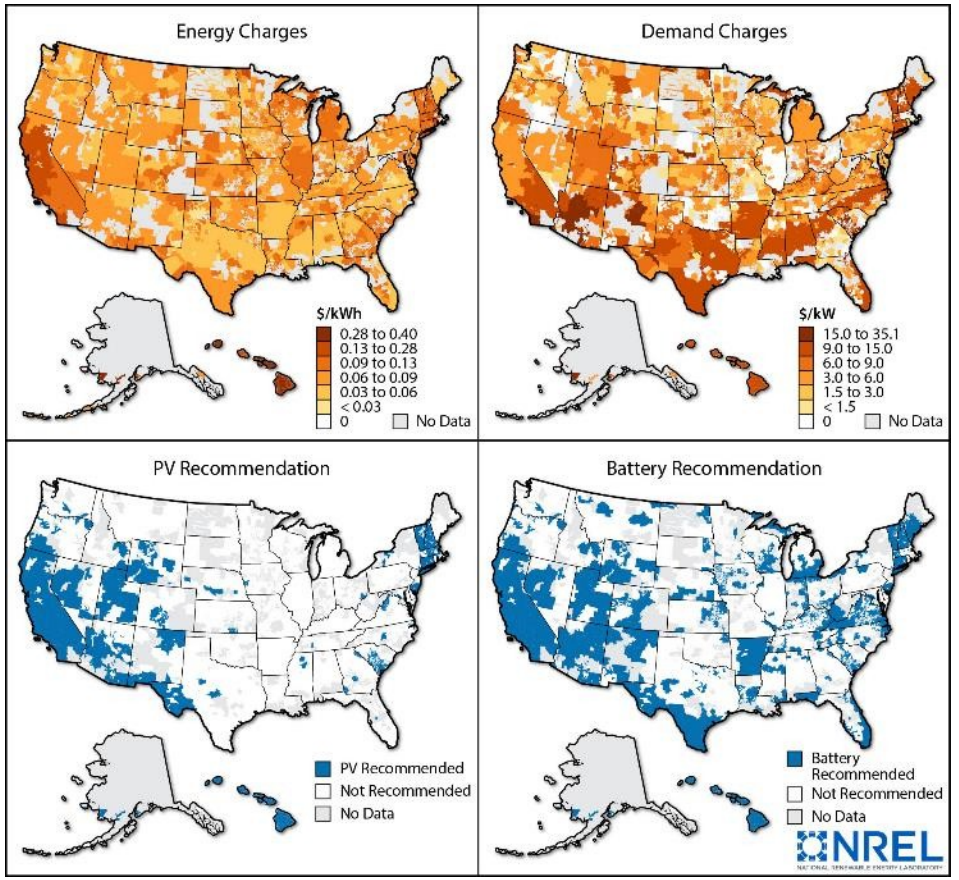
Renewable Energy & Emissions Impacts

	Business As Usual	Financial	Difference
System Size, Energy Production, and System Cost			
PV Size	0 kW	113 kW	113 kW
Annualized PV Energy Production	0 kWh	132,000 kWh	132,000 kWh
Battery Power	0 kW	0 kW	0 kW
Battery Capacity	0 kWh	0 kWh	0 kWh
Net CAPEX + Replacement + O&M	$0	$133,318	$133,318
Energy Supplied From Grid in Year 1	132,000 kWh	65,384 kWh	66,616 kWh
Year 1 Utility Cost — Before Tax			
Utility Energy Cost	$18,112	-$404	$18,515
Utility Demand Cost	$0	$0	$0
Utility Fixed Cost	$0	$0	$0
Utility Minimum Cost Adder	$0	$0	$0

Detailed Financial Outputs

Analysis Enabled by REopt API & Julia Package

- The REopt API & Julia package enable national-scale analysis of DER economics and impacts on deployment.
- For example:
  - Where in the country is storage (and PV) currently cost-effective?
  - At what capital costs is storage adopted across the United States?
  - How does varying utility rate, escalation rates, and incentive structures impact storage profitability?
  - How (and where) can stationary storage support DCFC electric vehicle economics and deployment?



NREL explored solutions for increasing affordability of DC fast charging (DCFC) nationwide through pairing with solar, storage, and building loads.

Accessing REopt

Interface	Description	Link
REopt Web Tool	• Easy-to-use web access • Key standardized capabilities • Results visualization • User accounts	reopt.nrel.gov/tool
REopt Application Programming Interface (API)	• Open-source code • Additional features and capabilities • Programmatic access facilitates large-scale analysis • API: Leverage NREL computational resources • Julia package: Faster solve times, users can run locally	github.com/NREL/REopt_API/wiki
REopt Julia Package		github.com/NREL/REopt.jl/wiki
REopt Analysis Scripts	• Scripts (e.g., Jupyter notebooks) to use the API and Julia package	github.com/NREL/REopt-Analysis-Scripts/wiki

Additional Resources

- **Web tool user guides**—Web tool user manual, quick-start videos and fact sheets, YouTube tutorials and webinars, curriculum materials: reopt.nrel.gov/user-guides.html
- **User forum**—Landing page for questions asked and answered regarding the web tool, API, Julia package, and analysis scripts: github.com/NREL/REopt-Analysis-Scripts/discussions

Additional Resources

- **NCSP+ Technical Assistance Program:**
  - Can be used to run specific scenarios and/or train staff.

- **Solar For All Technical Assistance Program:**
  - If modeling is specific to Solar For All, you can consider working with your regional awardee to scope REopt work into technical assistance.

- **Work directly with NREL:**
  - NREL can customize/expand REopt to meet specific needs.
  - NREL can use REopt directly to conduct analysis / technical assistance.

REopt website: nrel.gov/reopt

Tool feedback and questions: reopt@nrel.gov

www.nrel.gov

NLR/PR-7A40-94558

This work was authored by NREL for the U.S. Department of Energy (DOE), operated under Contract No. DE-AC36-08GO28308. Funding provided by the U.S. Department of Energy Federal Energy Management Program. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.