NREL
NATIONAL RENEWABLE ENERGY LABORATORY

REopt: Energy Decision Analysis Overview for Energizing Rural Communities

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REopt Integration and Optimization

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

Renewable Energy Resource

Technology Costs and Incentives

Site Goals (Economics, Resilience, Clean Energy)

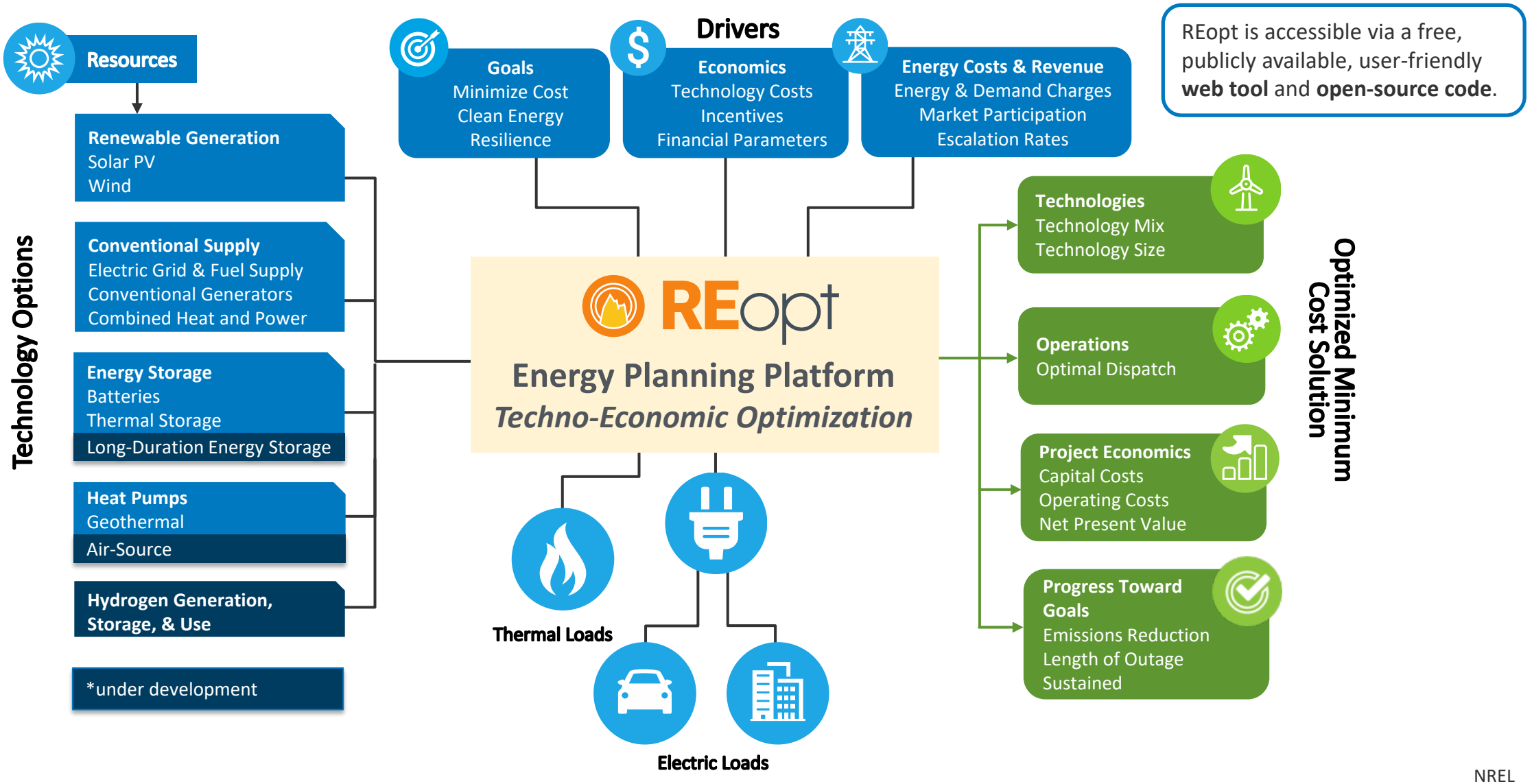
Utility Cost and Consumption

Financial Parameters

Many factors affect how DERs may provide cost savings, resilience, and clean energy 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.

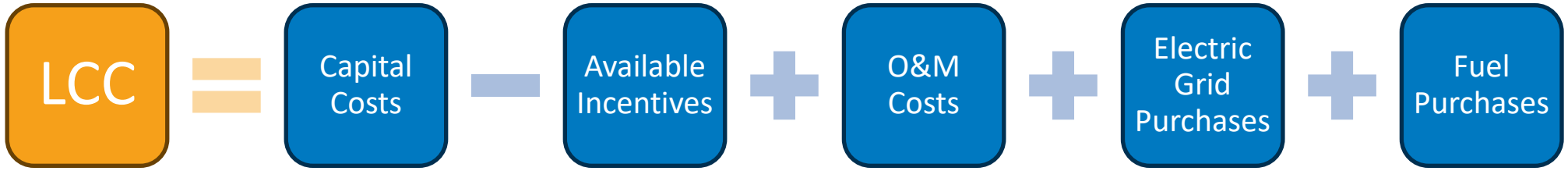


REopt is accessible via a free, publicly available, user-friendly **web tool** and **open-source code**.

REopt Minimizes the Life Cycle Cost of Energy

REopt identifies the **life cycle cost-optimal** DER system that achieves the site's energy goals (**cost savings**, **decarbonization**, and/or **resilience**).

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



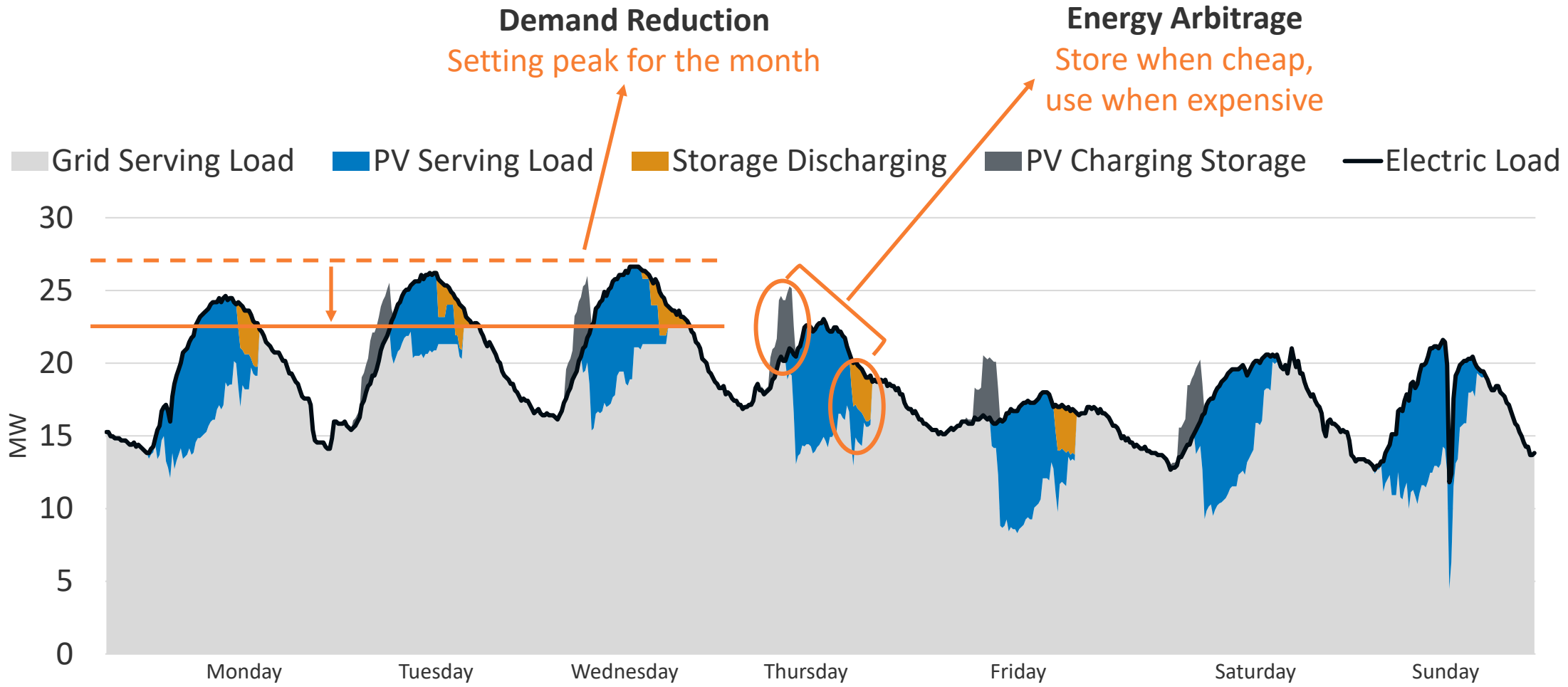
- **Net present value (NPV)** of DER system: The life cycle cost savings (difference in LCC) between the business-as-usual (BAU) case and the investment case.

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 Work?

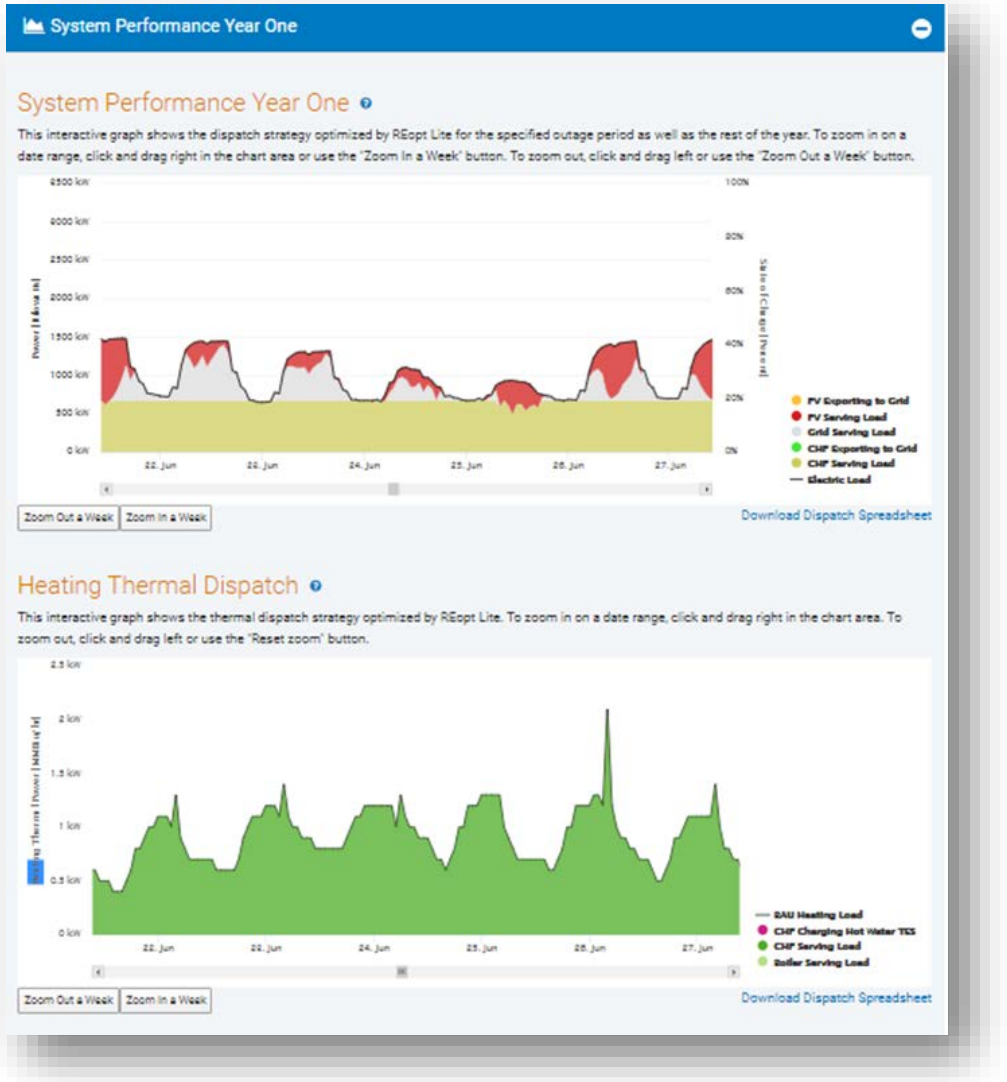
REopt considers the trade-off between ownership costs and savings across multiple value streams to recommend optimal size and dispatch.



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

Thermal Technologies in REopt

- In addition to solar PV, wind power, and BESS, REopt includes combined heat and power (CHP), geothermal heat pumps (GHP), absorption chillers, and thermal energy storage (TES).
- These technologies enable analyses of electric and thermal loads together:
  - Simultaneously serving heating and electricity loads with CHP
  - Electrifying heating loads with GHP
  - Generating cooling with excess heat rather than electricity with an absorption chiller
  - Value of decoupling thermal loads from thermal energy production with TES

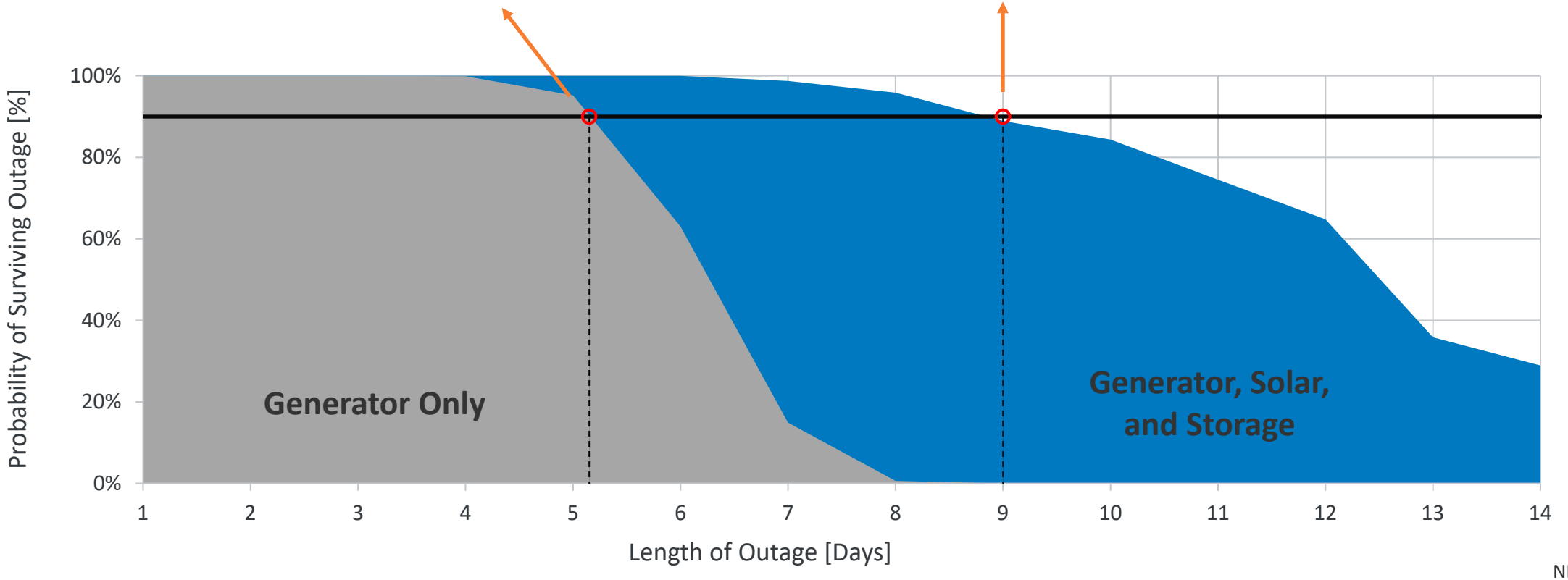


How Does REopt Evaluate Resilience?

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.

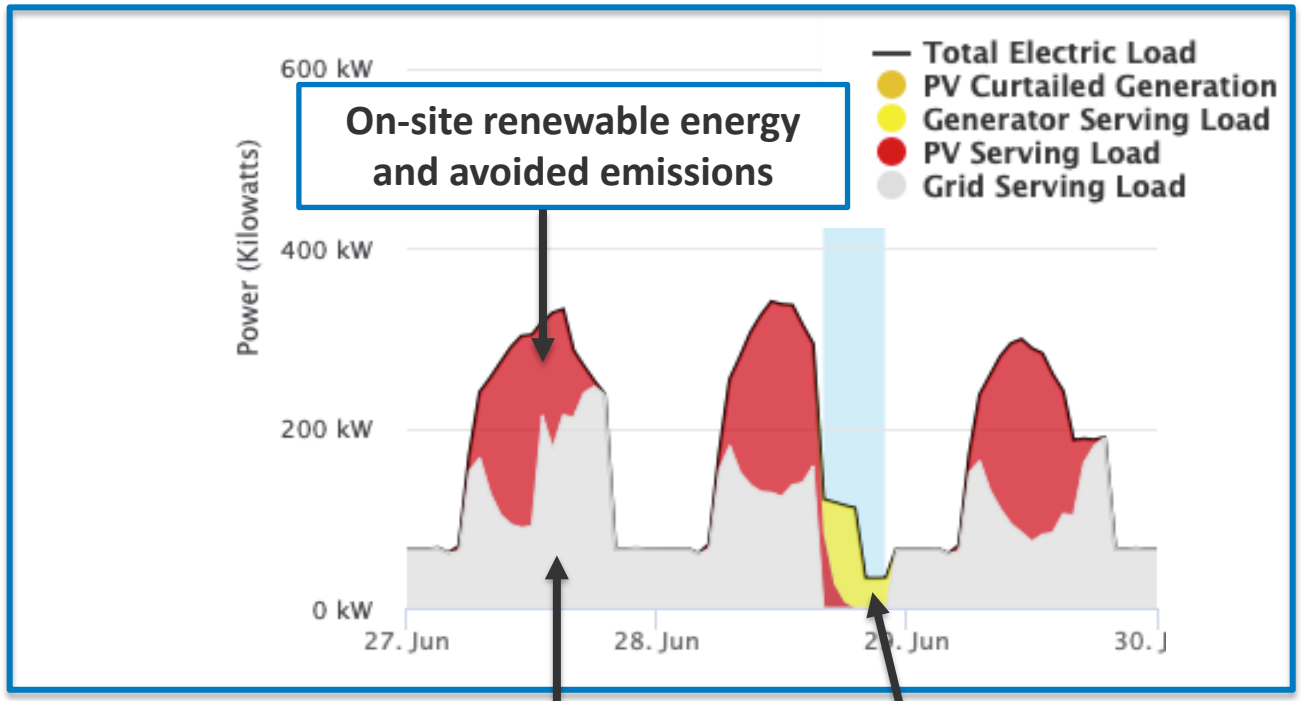
Existing generator with fixed fuel supply sustains the critical load for 5 days with 90% probability.

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 and Emissions Accounting in REopt

REopt calculates the renewable energy, emissions, and emissions cost impacts of a DER investment, accounting for the hourly emissions intensity of grid electricity as well as on-site fuel consumption.



Grid emissions [tonnes] =
Electric grid purchases [kWh]
x
Grid emissions intensity [tonne/kWh] of the grid (location-specific) in each hour

Fuel emissions [tonnes] =
Fuel burned on site [gal]
x
Fuel emissions intensity [tonne/gal]

Currently, REopt offers the following default assumptions, which users can choose to customize:

- **Grid emissions rates:** Regional hourly marginal climate and health emissions rates calculated from EPA's AVERT
- **Grid emission rate change projections (greening of the grid):** Calculated from NREL's Cambium dataset
- **Fuel emissions rates:** CO_2: EPA; NOx, SO_2, PM2.5: EPA WebFIRE database
- **Climate costs:** U.S. Interagency Working Group 2021 social cost of carbon
- **Health emissions costs:** Location-specific, obtained from EASIUR model

Users can also select different renewable energy and emissions accounting methodologies.

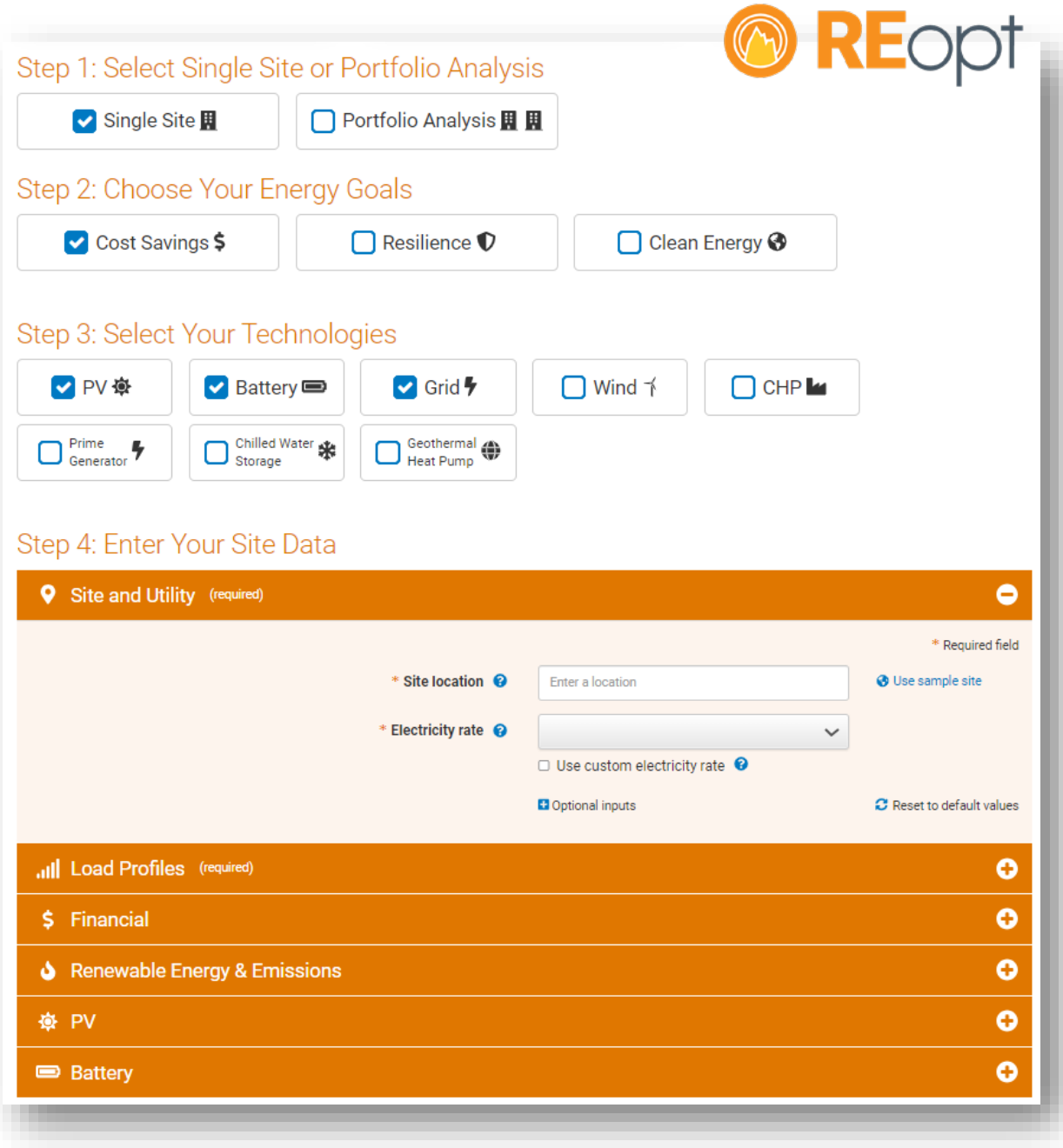
Clean Energy Accounting & Goals in REopt

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 **PV, wind, CHP, GHP, and energy storage** system sizes and dispatch strategies to **minimize life cycle cost of energy**
- **Resilience mode** optimizes DER systems, along with backup generators, to sustain critical load during grid outages
- **Clean energy goals** allow users to consider renewable energy targets, emissions reductions targets, and emissions costs in optimization
- Access the REopt web tool at reopt.nrel.gov/tool.



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

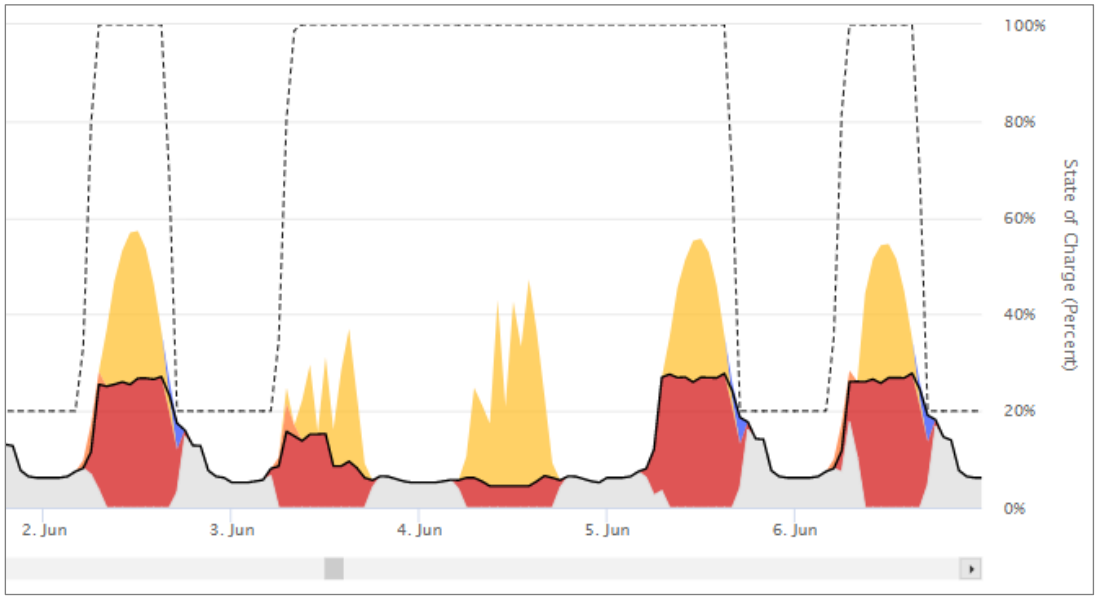
This system size minimizes the life cycle cost of energy at your site. The battery power and capacity are optimized for economic performance.

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

Climate and Health 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

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

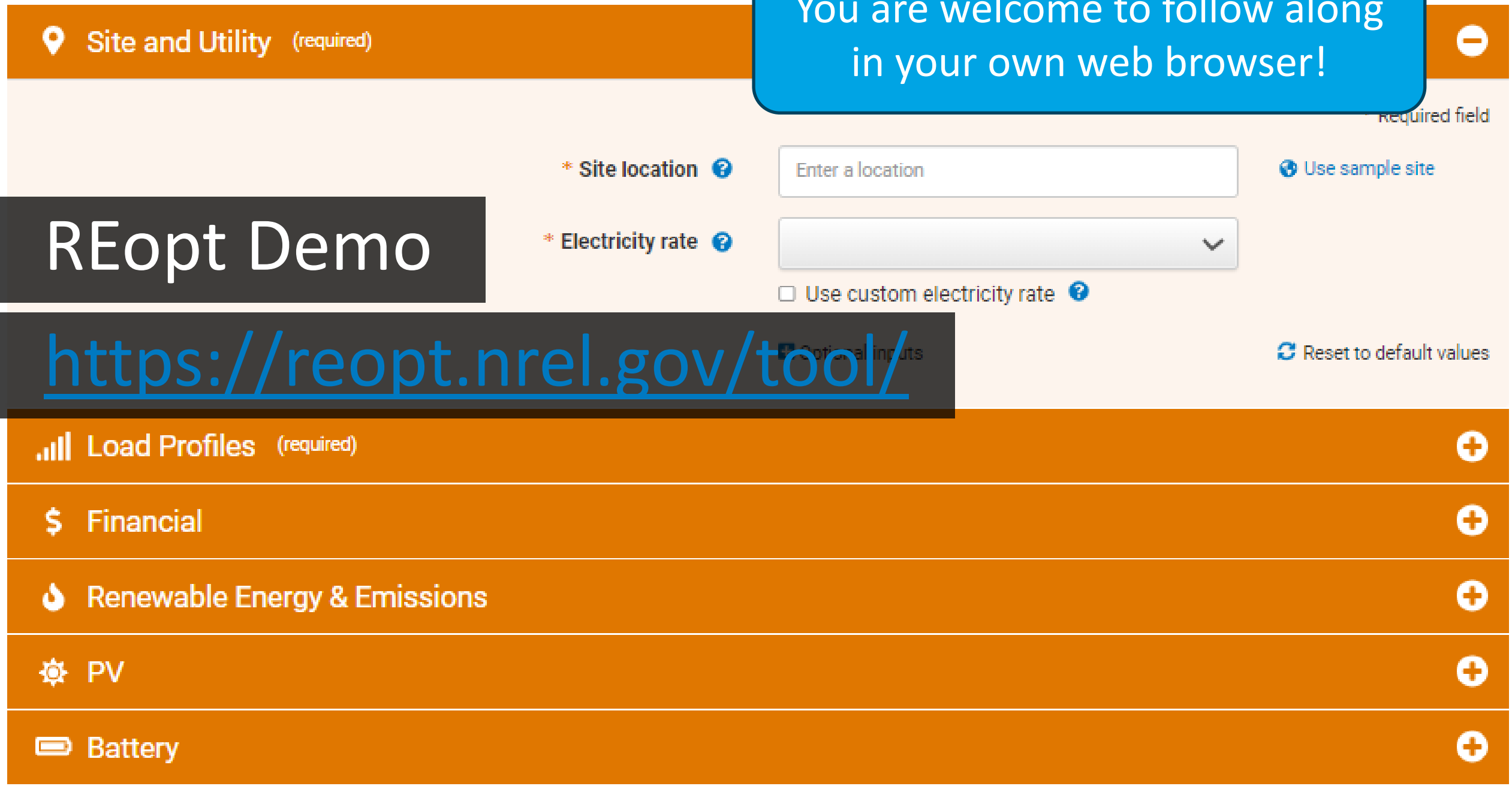
- **Web tool user guides**—Web tool user manual, quick-start videos and fact sheets, YouTube tutorials and webinars, curriculum materials: reopt.nrel.gov/user-guides.html
- **User forum**—Landing page for questions asked and answered regarding the web tool, API, Julia package, and analysis scripts: github.com/NREL/REopt-Analysis-Scripts/discussions

Step 4: Enter Your Site Data

You are welcome to follow along in your own web browser!

REopt Demo

https://reopt.nrel.gov/tool/



REopt Renewable Energy Integration and Optimization

REopt website (analysis services and case studies): reopt.nrel.gov

Tool feedback and questions: reopt@nrel.gov

www.nrel.gov

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