# REopt Lite Web Tool: Capabilities and Features

NREL REopt Team

reopt.nrel.gov/tool

# The Nation's Energy Supply Is in the Midst of a Transformation

- As costs decrease, renewable energy (RE) deployment is growing worldwide;
- Generation is increasingly distributed, with 31% of new capacity behind-the-meter; and
- With increasingly integrated and complex systems, back-of-the envelope calculations are no longer sufficient to determine distributed energy project potential.


# REopt Lite Web Tool Transforms Complex Decisions Into Actionable Results

- The free, publicly available web tool guides investment in economic, resilient energy technologies;
- Based on decades of NREL decision-support expertise, REopt Lite™ transforms complex decisions into actionable results for building owners, utilities, and industry; and
- Open Source and API access to the tool enables analysis at scale.

# Will RE + Storage Work for Your Site?

**RE Resource**

**Technology Costs & Incentives**

**Resilience Goals**

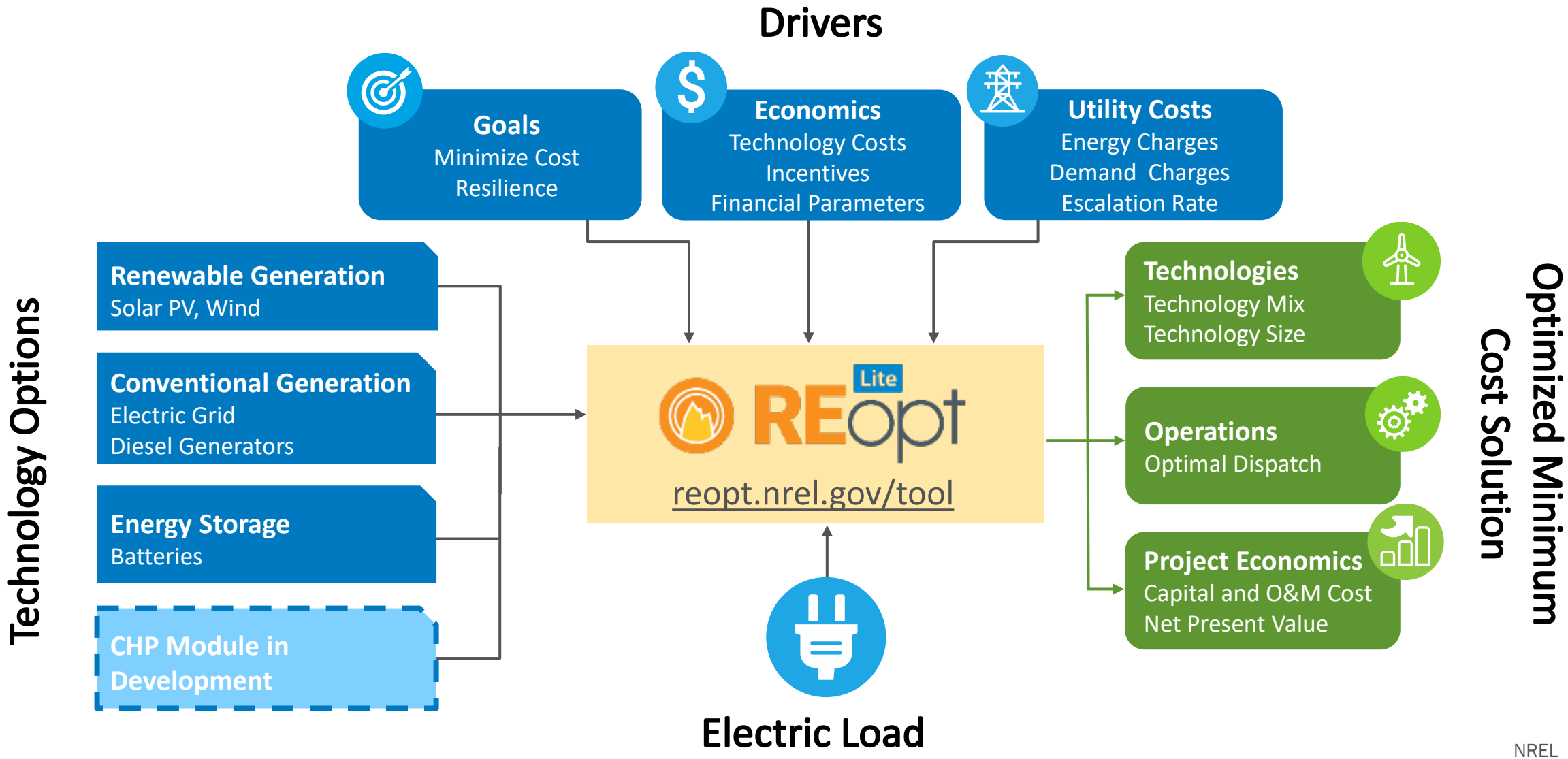
**Utility Cost & Consumption**

**Financial Parameters**

***Many factors affect whether distributed energy technologies can provide cost savings and resilience to your site, and they must be evaluated concurrently.***

# REopt Lite: Free Web Tool to Optimize Economic and Resilience Benefits of DERs

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



# REopt Lite Provides Solutions for a Range of Users

*Researchers, developers, building owners, utilities, and industry use the tool to answer different questions.*


What is the optimal size of DERs to minimize my cost of energy?

How do I optimize system control across multiple value streams to maximize project value?

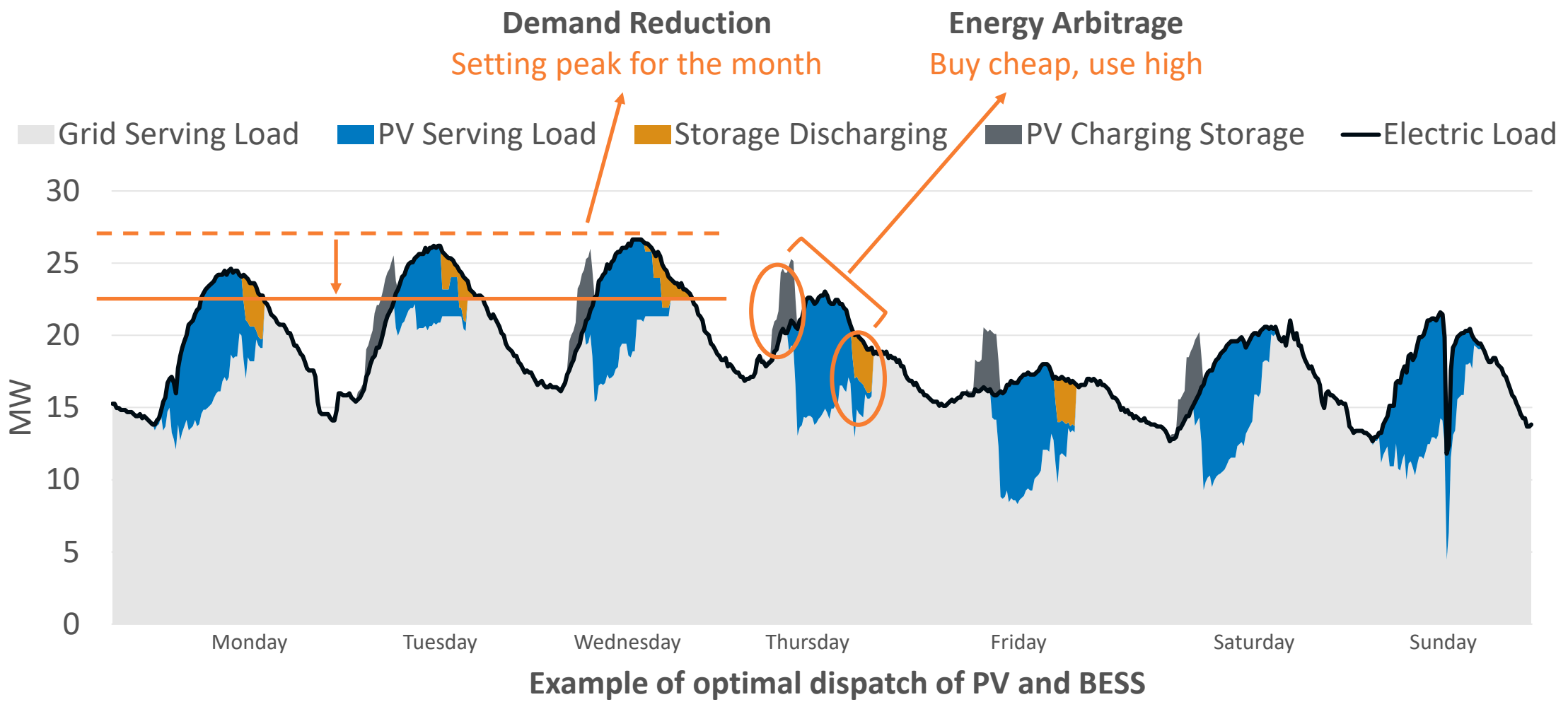

Where do market opportunities for DERs exist? Now and in the future?

What will it cost to meet a sustainability or on-site generation goal?

What is the most cost-effective way to survive a grid outage spanning 1 day? What about 9 days?

# How Does REopt Lite Work?

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

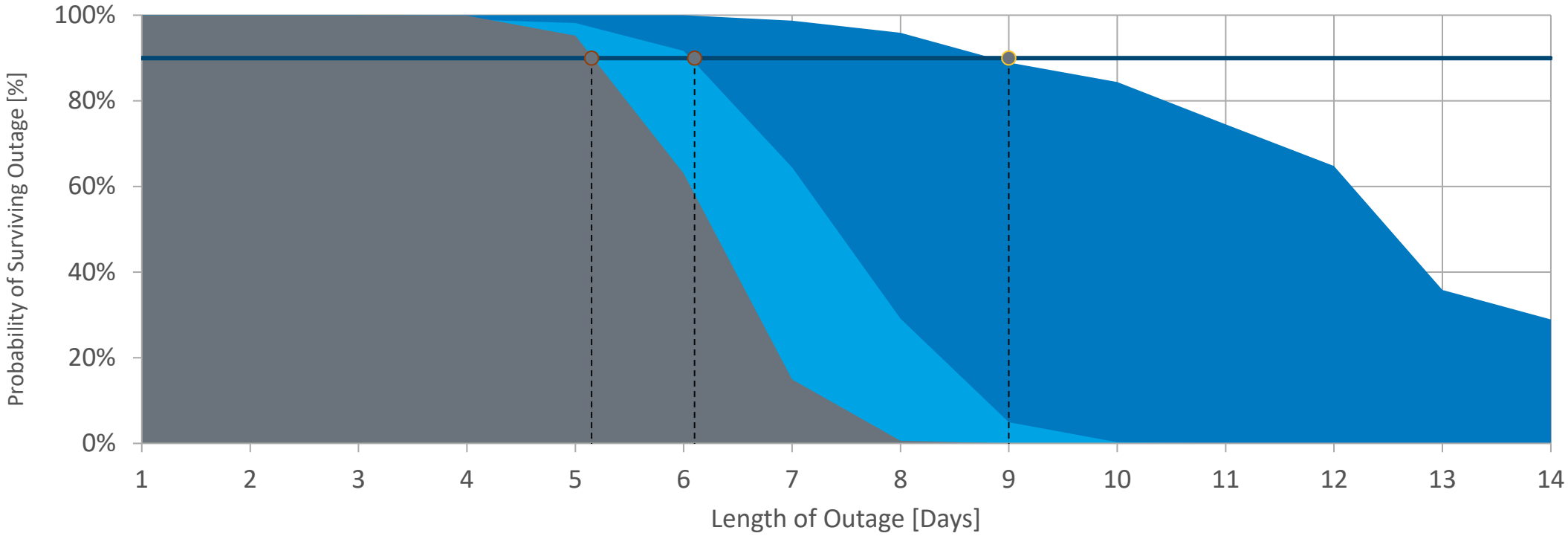



**Example of optimal dispatch of PV and BESS**

# How Does REopt Lite Work for Resilience?

***REopt Lite evaluates thousands of random grid outages to estimate hours survived and impact on life cycle cos. It quantifies the economic and resilience benefit of DERs by comparing the number of hours the site could survive with different technology combinations.***

| | 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 | $18.5 million | 6 days |
| 3. Proposed system | 2.5 MW | 2 MW | 500 kWh | $19.9 million | 9 days |

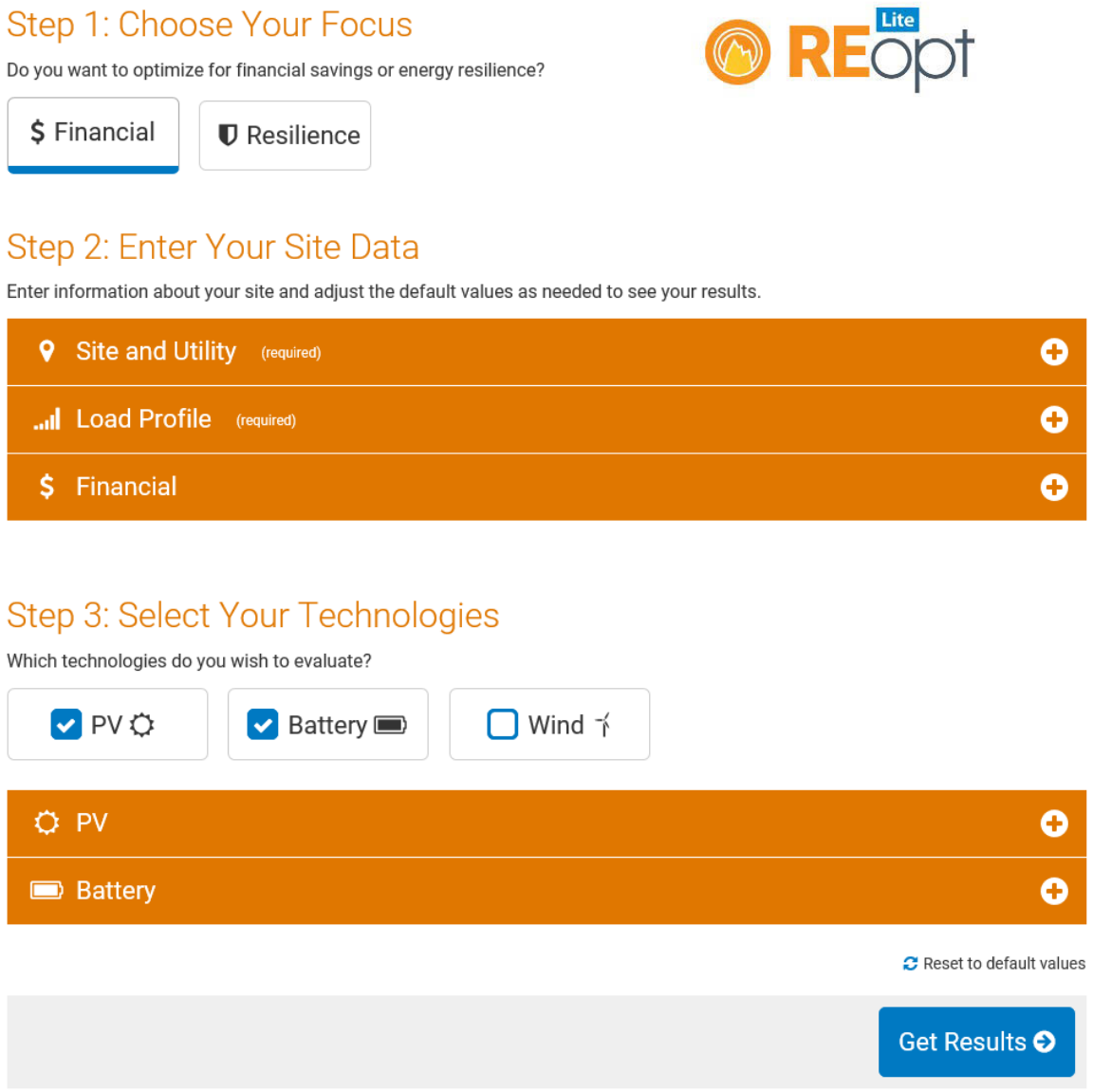


# REopt Lite Web Tool

User Interface and Key Results

# REopt Lite User Interface

- **REopt Lite** is a web tool that offers a no-cost subset of NREL's more comprehensive REopt™ model;
- **Financial mode** optimizes PV, wind, and battery system sizes and battery dispatch strategy to minimize life cycle cost of energy; and
- **Resilience mode** optimizes PV, wind, and storage systems, along with backup generators, to sustain critical load during grid outages.
- Access REopt Lite at [reopt.nrel.gov/tool](reopt.nrel.gov/tool).



# REopt Lite Key Outputs

## Results for Your Site

New Evaluation

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

REopt Lite

Back

**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

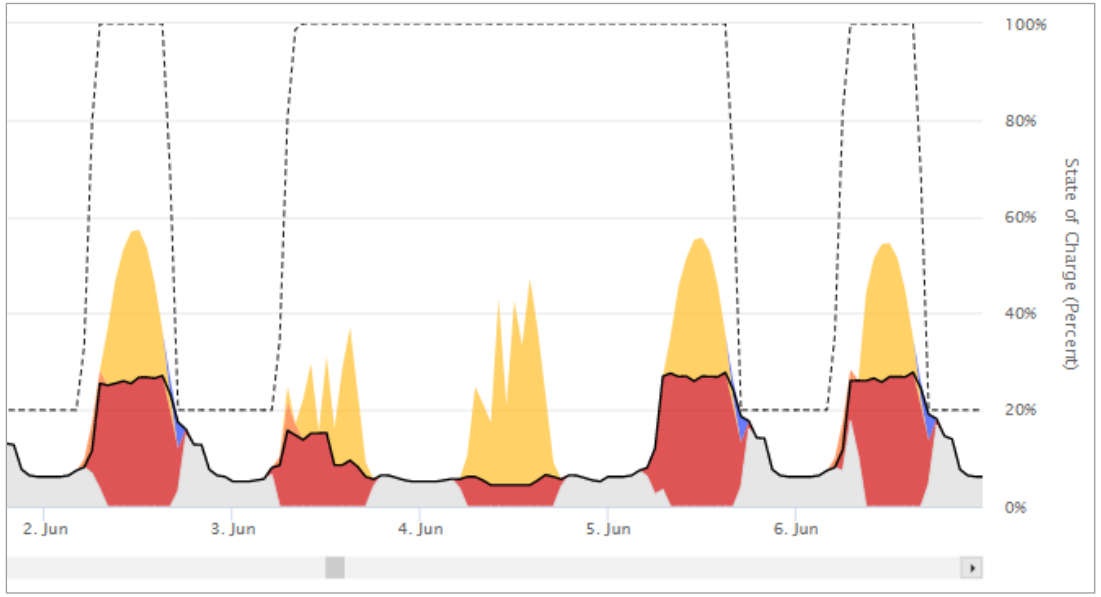
This system size minimizes the life cycle cost of energy at your site. The battery power and capacity are optimized for economic performance.

**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***



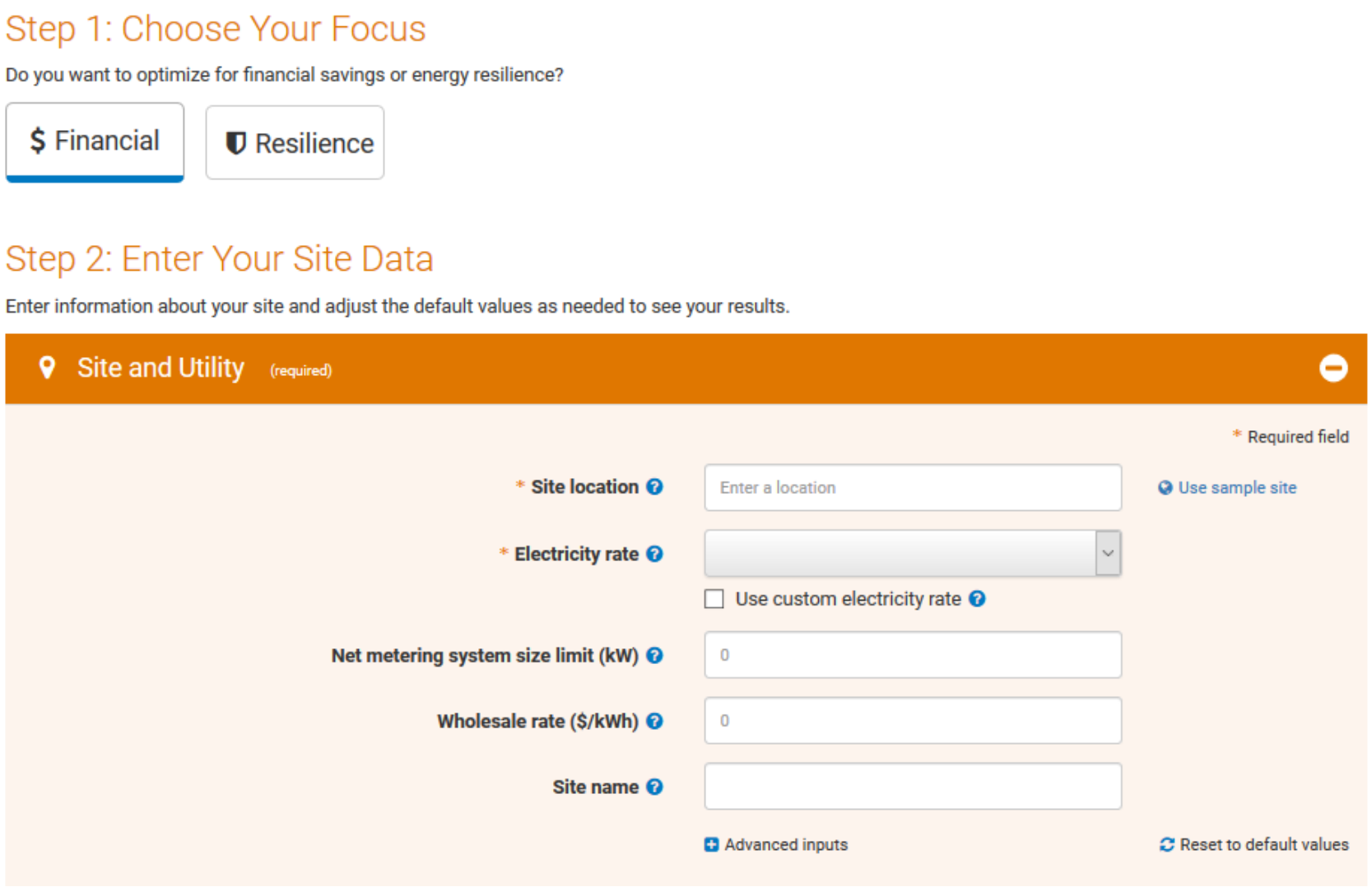

***Hourly Dispatch***

| | Business As Usual | Financial | Difference |
|---|---|---|---|
| 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***

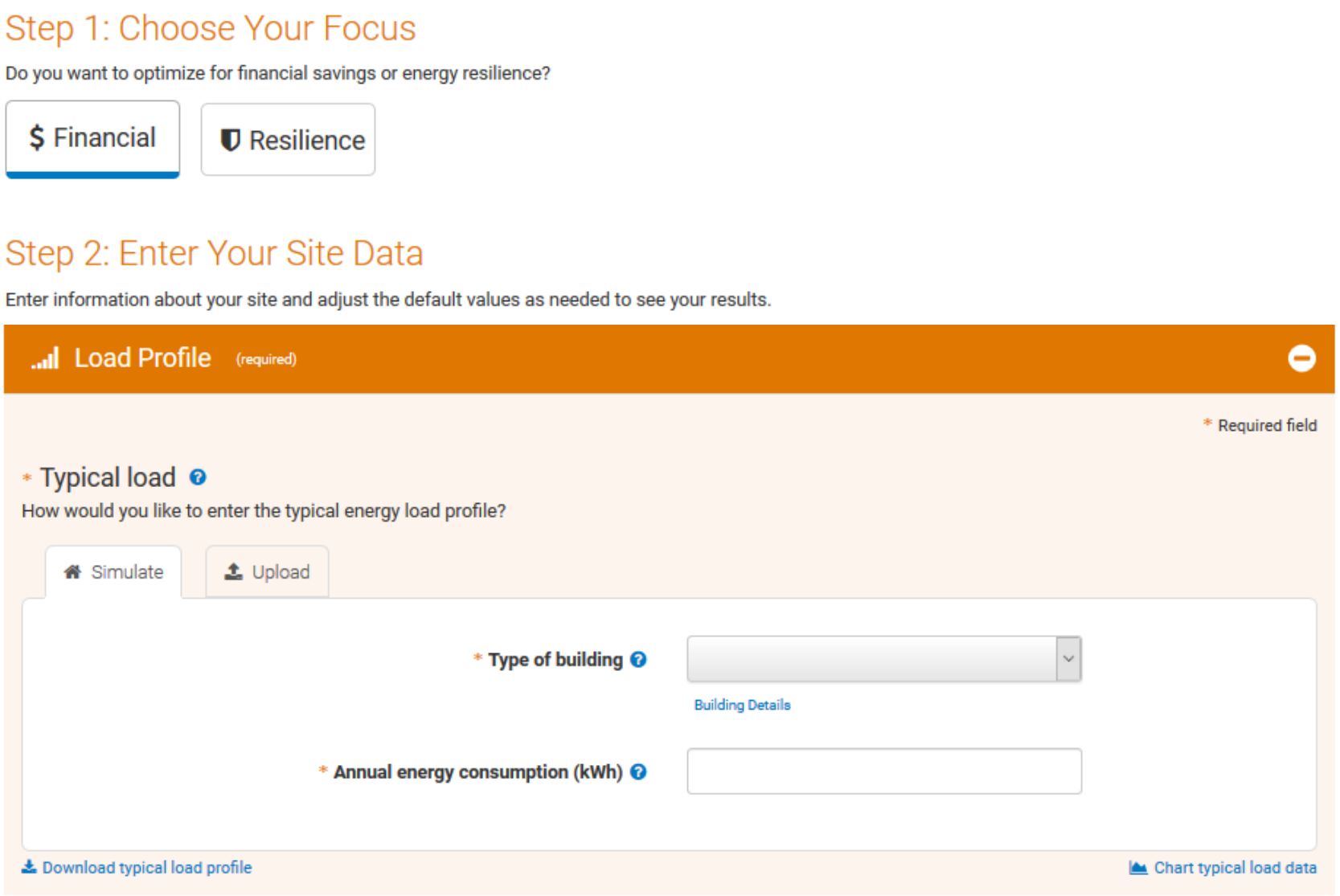
# REopt Lite Financial Mode

# Required Site Specific Inputs (Financial Mode)



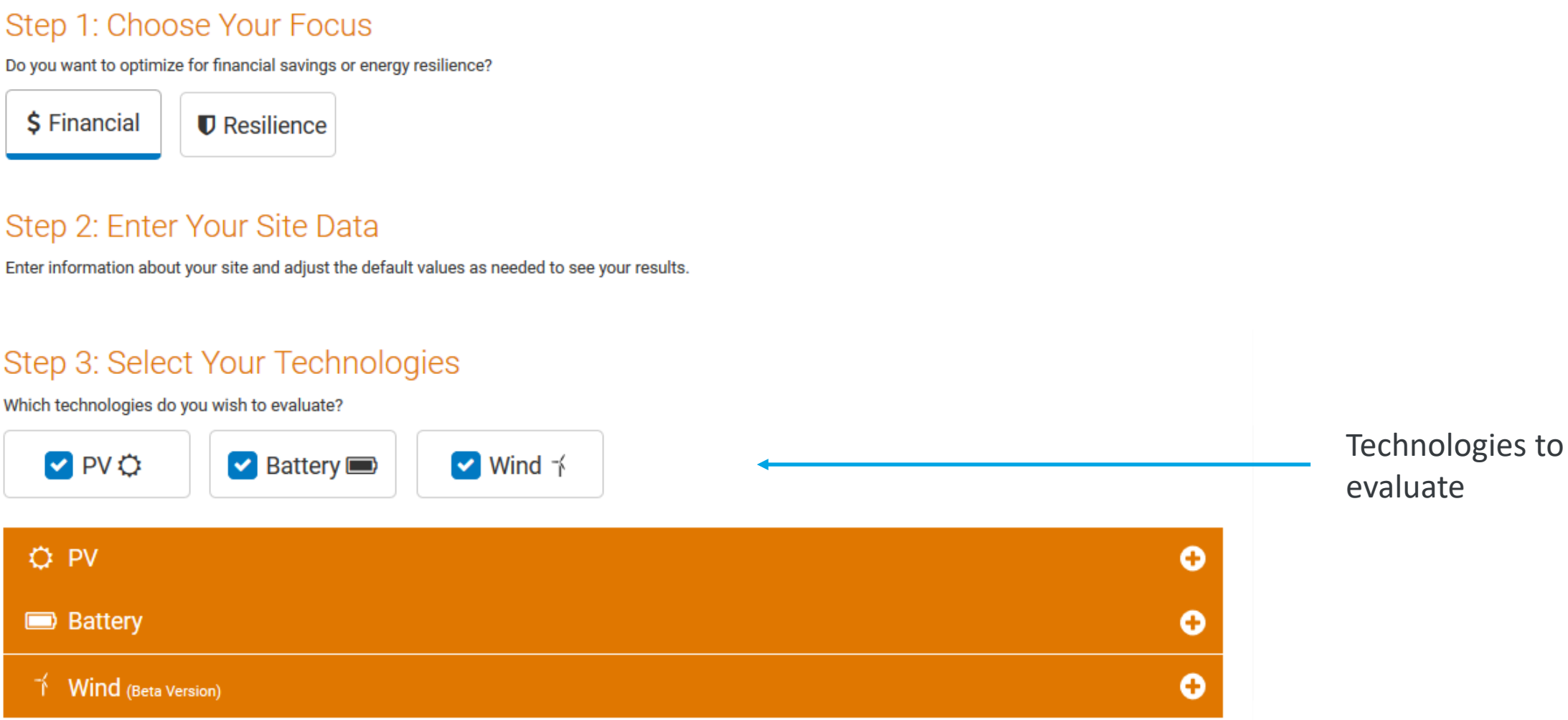

Location and utility rate

# Required Site Specific Inputs (Financial Mode)



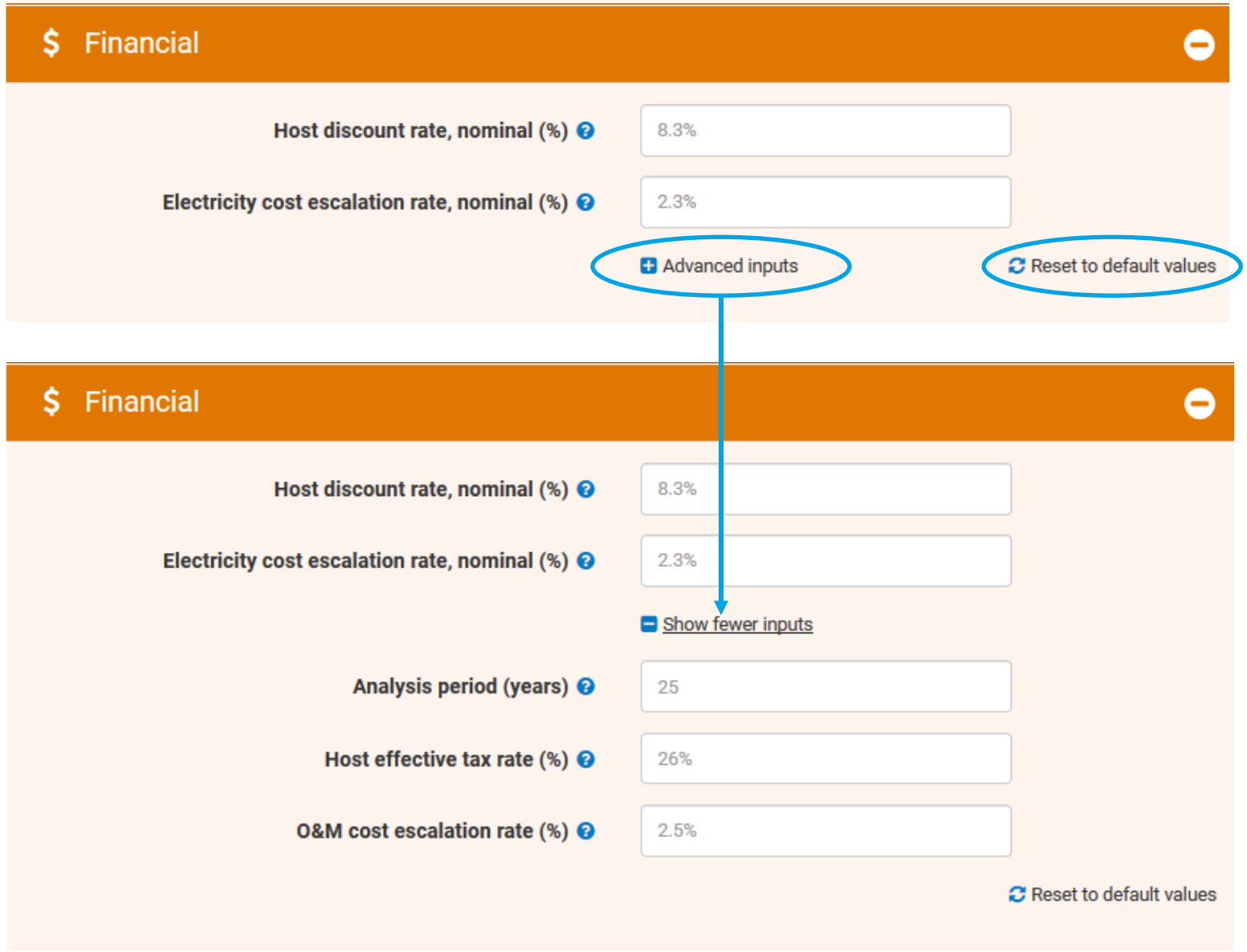

Load profile – simulated or actual

# Required Site Specific Inputs (Financial Mode)

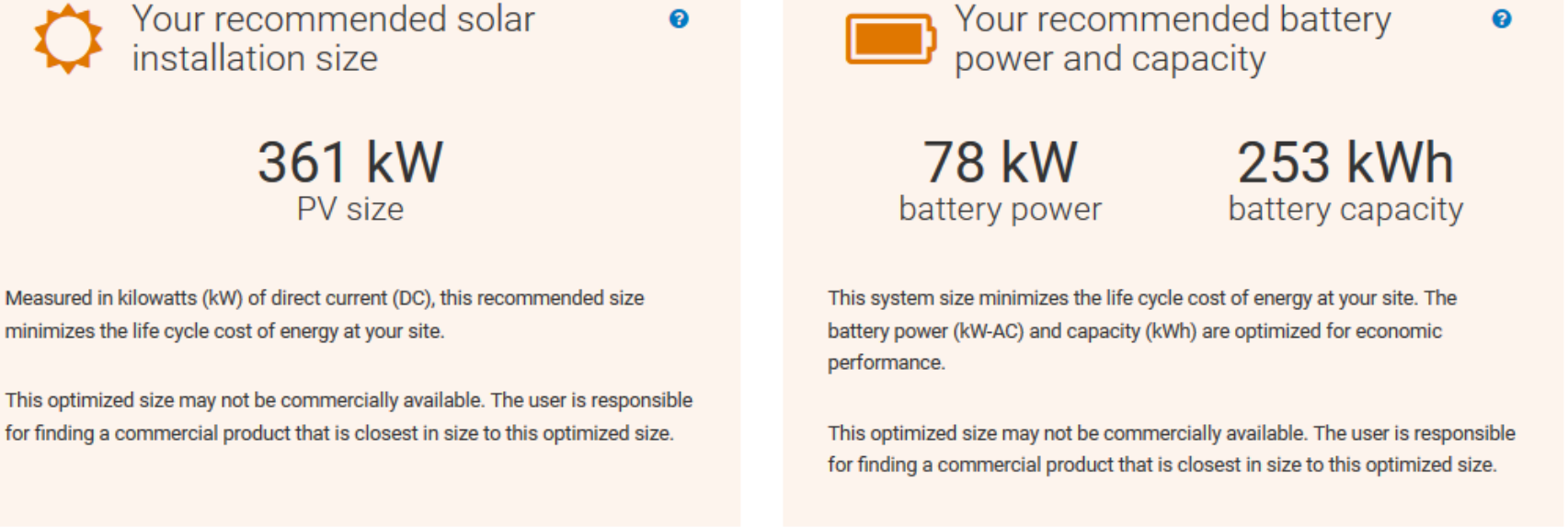



Technologies to evaluate

# Additional Inputs Can Be Edited Or Left As Defaults

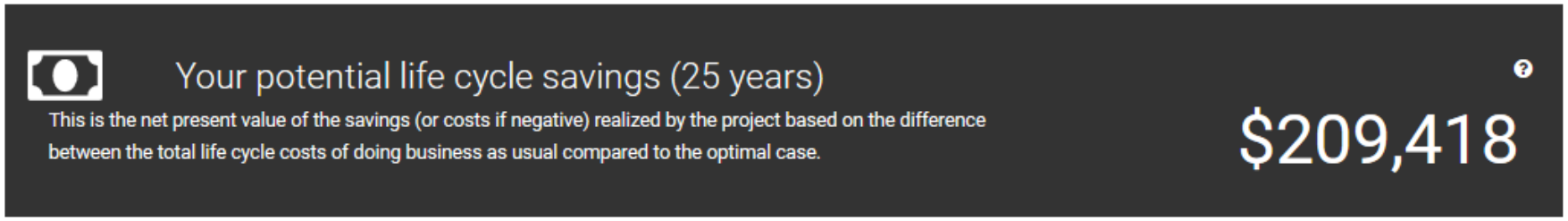


# Key Results Output: System Sizes and Savings




Optimal system sizes are outputs of the tool.

Battery power (kW) and energy (kWh) are sized independently.




Net present value of savings after capital and operations and maintenance (O&M) costs.

# Additional Results Output: Economics Summary

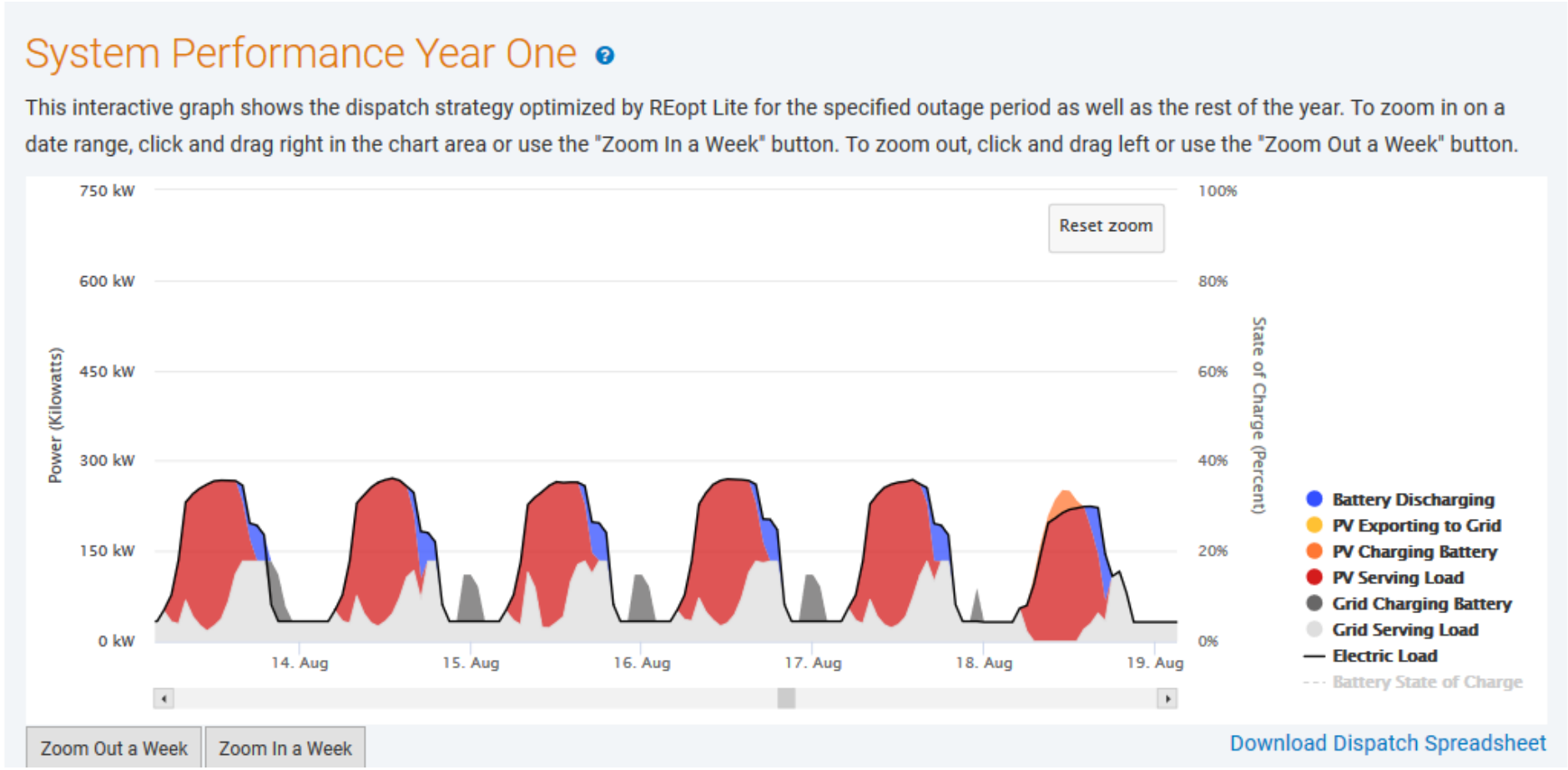
| | Business As Usual | Financial | Difference |
|---|---|---|---|
| System Size, Energy Production, and System Cost | | | |
| **PV Size** | 0 kW | 361 kW | 361 kW |
| **Annualized PV Energy Production** | 0 kWh | 577,409 kWh | 577,409 kWh |
| **Battery Power** | 0 kW | 78 kW | 78 kW |
| **Battery Capacity** | 0 kWh | 253 kWh | 253 kWh |
| **Net CAPEX + Replacement + O&M** | $0 | $532,744 | $532,744 |
| **Energy Supplied From Grid in Year 1** | 1,000,000 kWh | 448,266 kWh | 551,734 kWh |
| Year 1 Utility Cost — Before Tax | | | |
| **Utility Energy Cost** | $74,602 | $31,430 | $43,172 |
| **Utility Demand Cost** | $80,133 | $45,853 | $34,280 |
| **Utility Fixed Cost** | $5,551 | $5,551 | $0 |
| **Utility Minimum Cost Adder** | $0 | $0 | $0 |
| Life Cycle Utility Cost — After Tax | | | |
| **Utility Energy Cost** | $714,851 | $301,166 | $413,685 |
| **Utility Demand Cost** | $767,851 | $439,375 | $328,476 |
| **Utility Fixed Cost** | $53,191 | $53,191 | $0 |
| **Utility Minimum Cost Adder** | $0 | $0 | $0 |
| Total System and Life Cycle Utility Cost — After Tax | | | |
| **Total Life Cycle Costs** | $1,535,894 | $1,326,476 | $209,418 |
| **Net Present Value** | $0 | $209,418 | $209,418 |

Download ProForma Spreadsheet

Compare the business as usual case with the optimal results from REopt Lite.

Download pro forma for more detailed financial results.

# Additional Results Output: Hourly Dispatch Graph



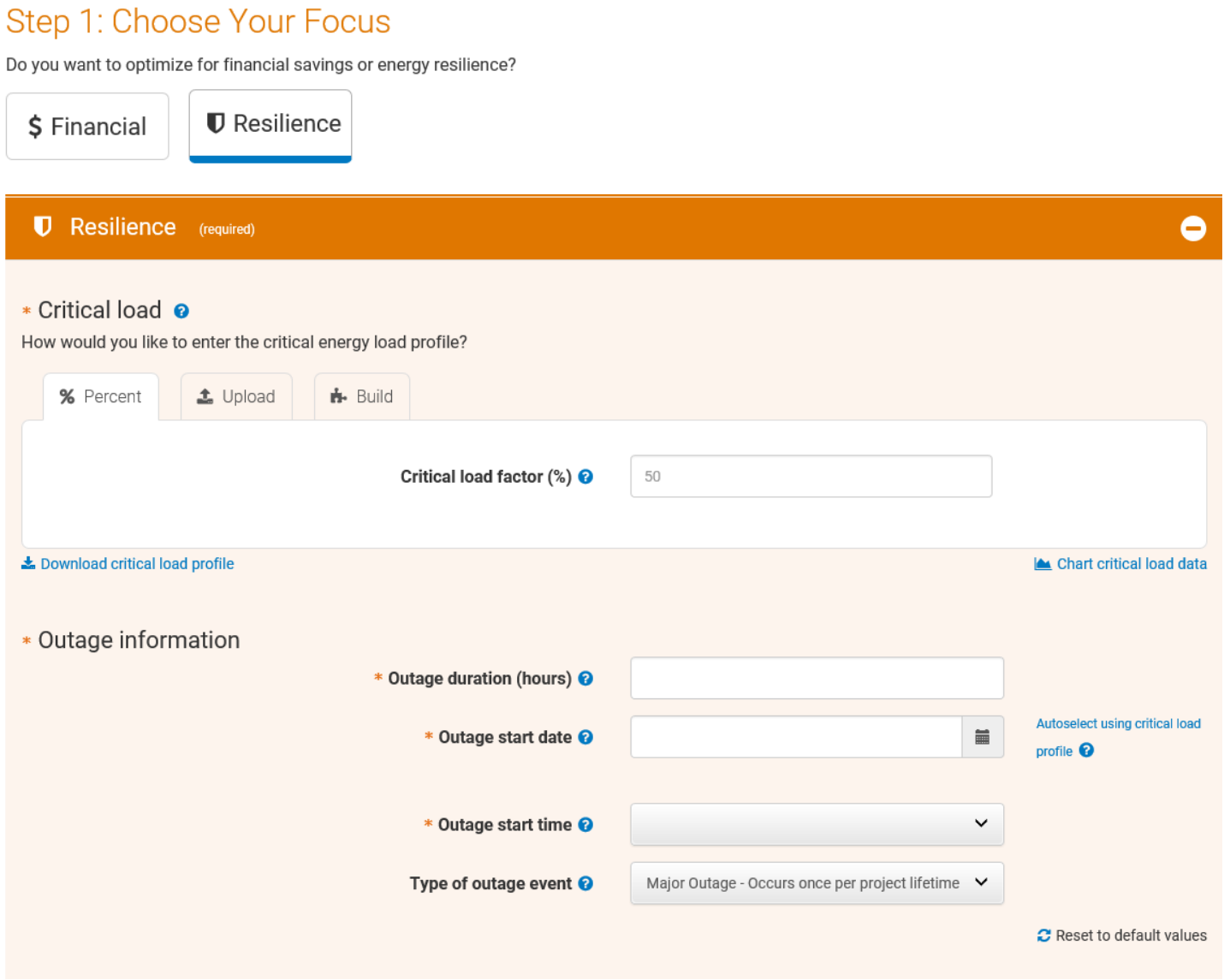

Turn technologies on or off.

Zoom in and out to look at a day, week, and year.

Download hourly data.

# REopt Lite Resilience Mode

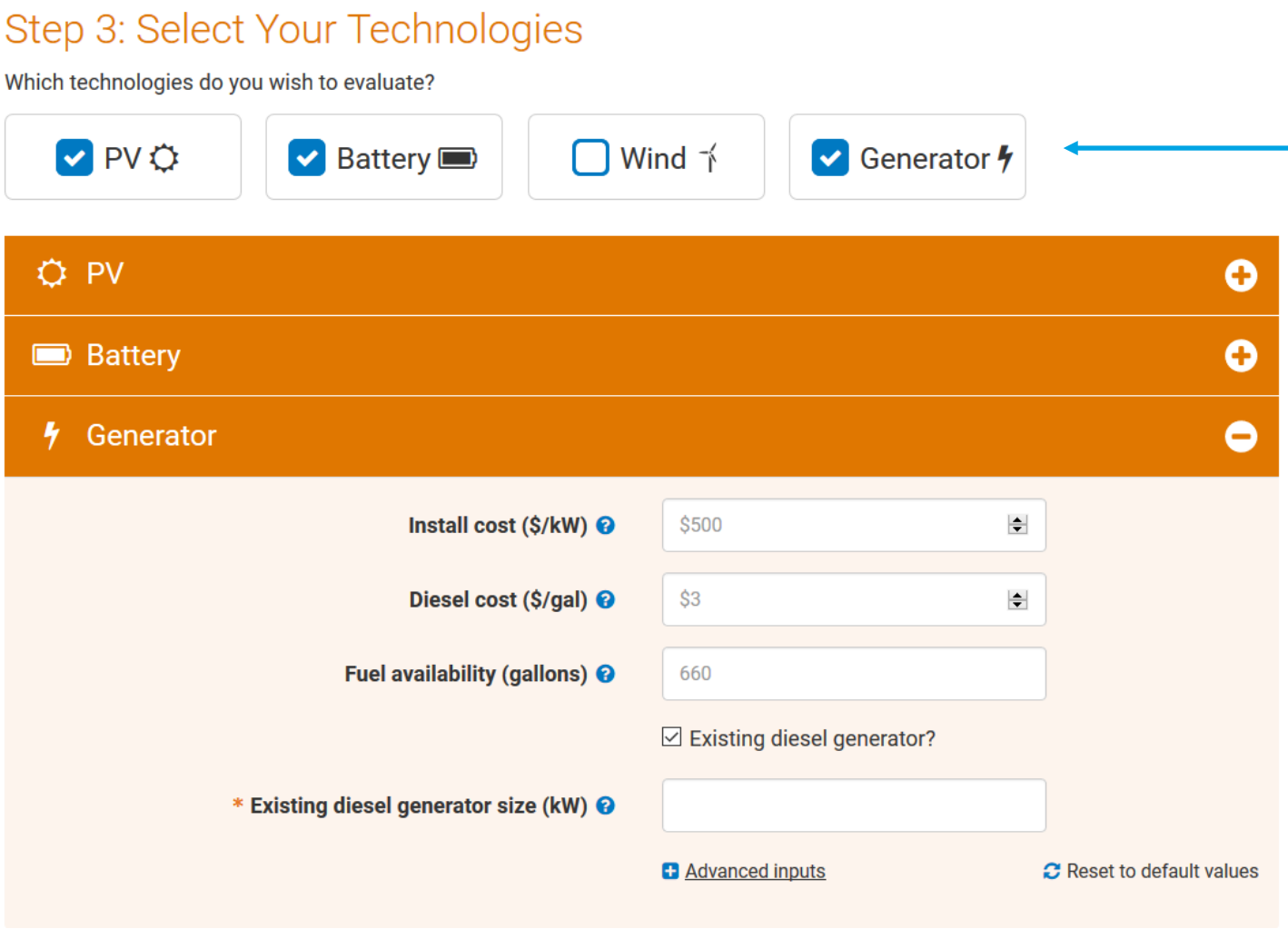
# Required Resilience Inputs




What load needs to be met during the outage?

When is the outage expected to occur, and how long will it last?

# Additional Resilience Input: Generator Modeling




Generator option for resilience evaluation

Specify existing generator, and/or let REopt Lite size it.

Defaults are for a diesel generator but can be modified.

# Resilience Output: System Sized to Meet Outage

## Your Potential Resilience

This system sustains the 75% critical load during the specified outage period, from January 4 at 12am to January 11 at 12am.

System survives specified 168-hour outage

This system sustains the critical load for 72% of all potential 168 hour outages throughout the year.

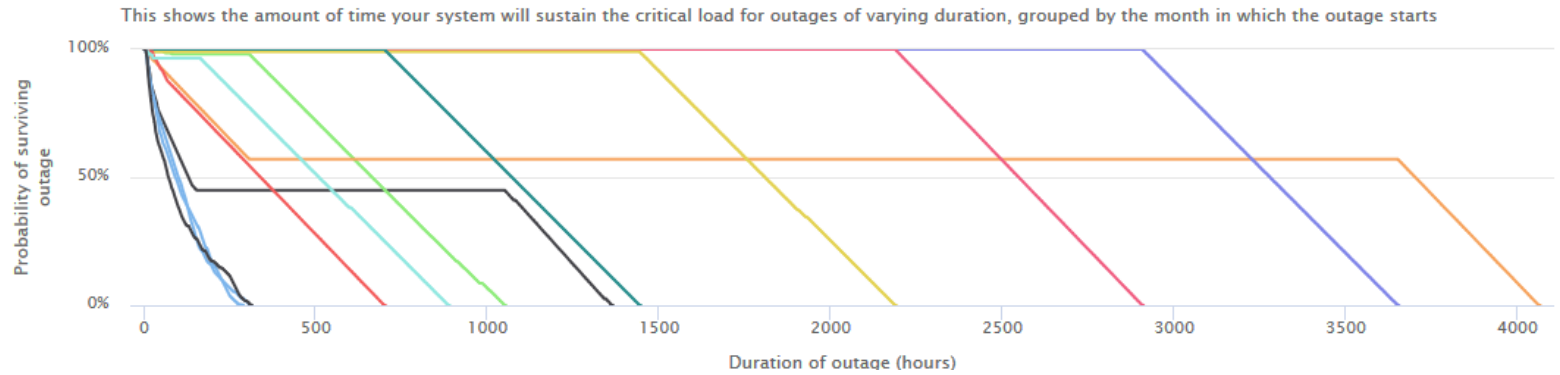
72% System survives 72% of 168-hour outages

REopt Lite optimizes system size and dispatch to survive specified outage.

## Outage Simulation

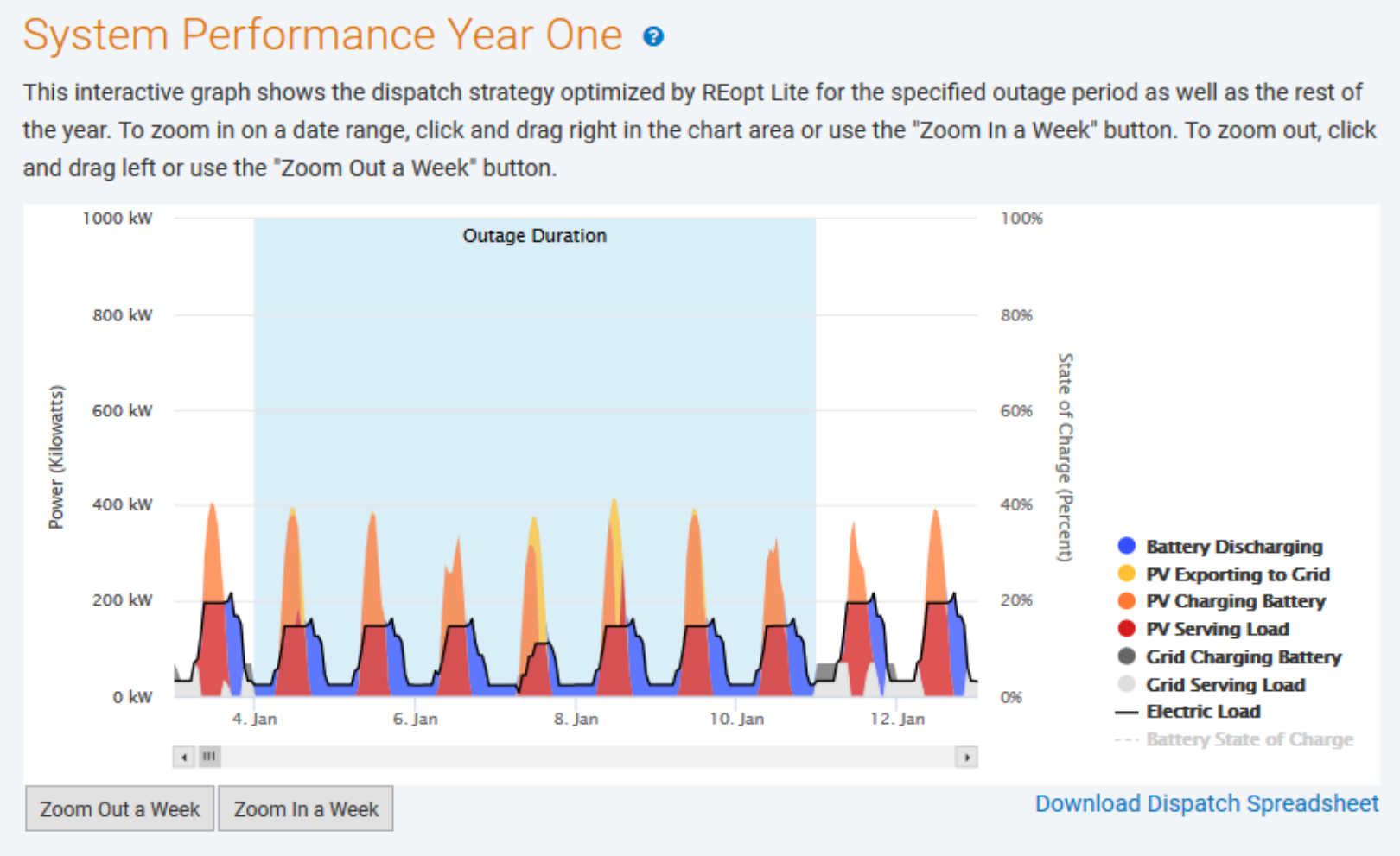
Evaluate the amount of time that your system can survive grid outages.

Yearly | Monthly | Hourly




REopt Lite simulates outages of varying length throughout the year.

# Resilience Output: Dispatch During Outage




The specified outage event is highlighted in blue (lower load).

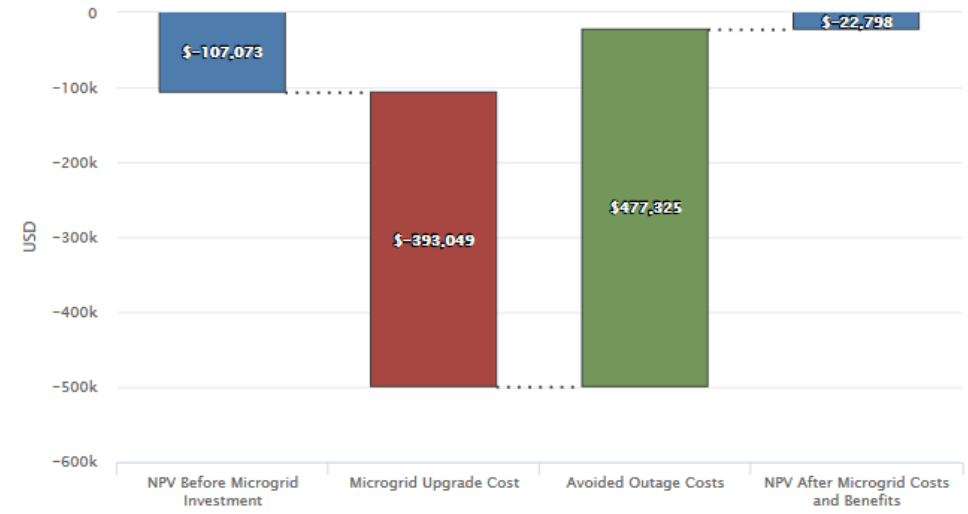
The load is met exclusively by the PV and storage that REopt Lite selected.

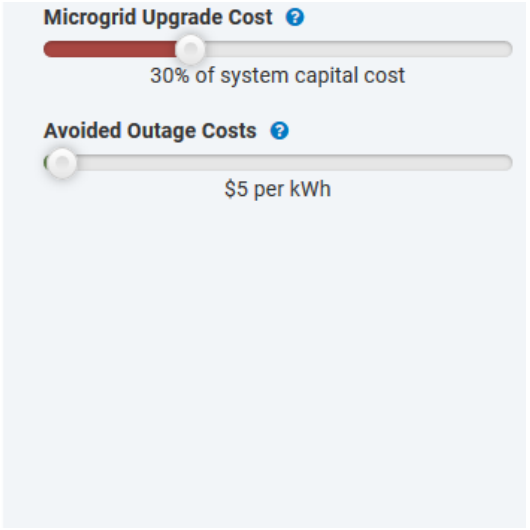
As soon as the outage ends, the site goes back to purchasing grid electricity.

# Resilience Output: Comparison to Optimum and Cost Sliders

| | Business As Usual | Resilience | Financial |
|---|---|---|---|
| System | None | 729 kW PV<br>220 kW Battery<br>1,288 kWh Battery | 361 kW PV<br>78 kW Battery<br>253 kWh Battery |
| NPV | $0 | -$107,073 | $209,419 |
| Survives Specified Outage | No | Yes | No |
| Average | 0 hrs | 1,115 hrs | 10 hrs |
| Minimum | 0 hrs | 4 hrs | 0 hrs |
| Maximum | 0 hrs | 4,061 hrs | 63 hrs |

Compare results of resilience analysis to financial optimum.



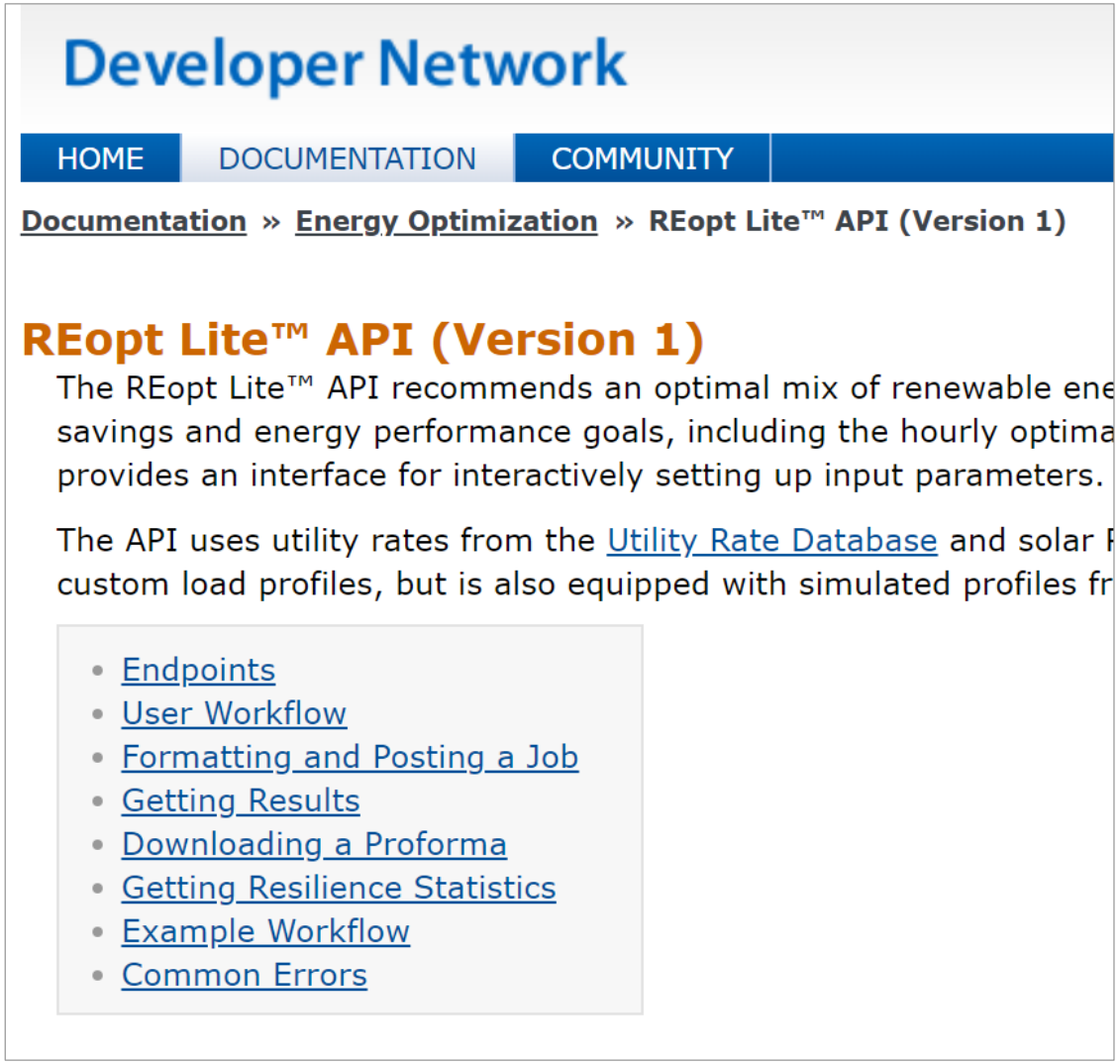




Explore impact of microgrid upgrade costs and value of avoiding an outage.

# REopt Lite API and FY20 Development Plans

# REopt Lite API

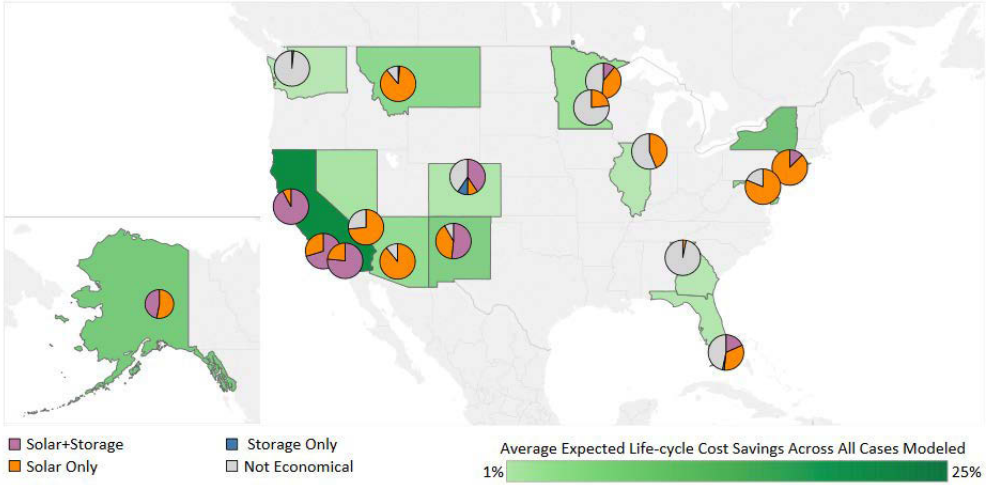
- What is an API?
  - Application Programming Interface
  - Programmatic way of accessing REopt Lite (sending and receiving data from a server)
  - File format used for sending and receiving the data: JSON.
- Advantages:
  - Multiple simulations for different sites can be run programmatically;
  - Scenario analysis can be automated; and
  - Application can be integrated with other programs.



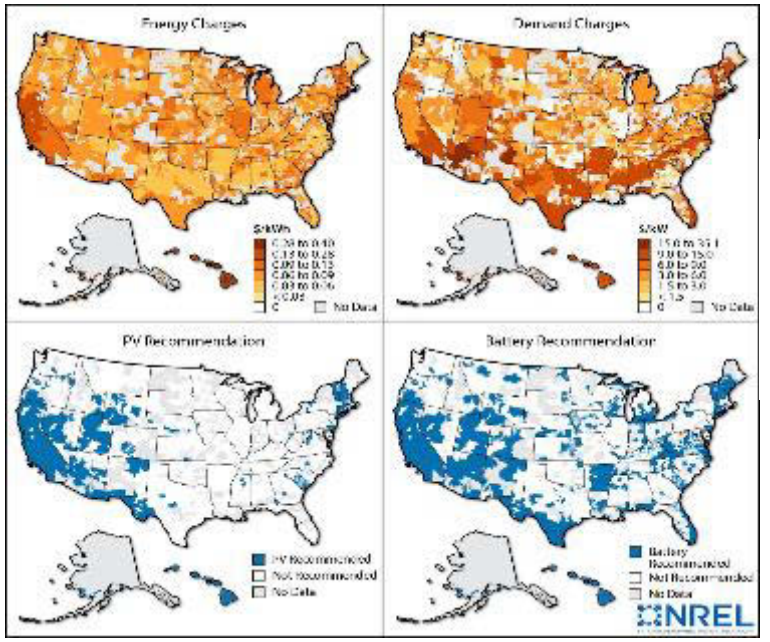

https://developer.nrel.gov/docs/energy-optimization/reopt-v1/

# Analysis Enabled by API

- The REopt Lite API enables national-scale analysis of storage economics and impacts on adoption/deployment.
- Analysis questions include:
  - 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 DC-fast-charging electric vehicle economics and deployment?




*Identifying Critical Factors in the Cost-Effectiveness of Solar and Battery Storage in Commercial Buildings*
https://www.nrel.gov/docs/fy18osti/70813.pdf




*Technology Solutions To Mitigate Electricity Cost for Electric Vehicle DC Fast Charging*
https://www.sciencedirect.com/science/article/pii/S0306261919304581

# FY20 REopt Lite Developments

| Task | Description |
|---|---|
| **EV load profiles** | Develop standard load profiles and integrate in REopt Lite |
| **Third-party financing** | Financial model of third-party ownership |
| **Federal button** | Federal button with analysis assumptions and results geared toward federal user |
| **Utility rate improvements** | Add additional rate features such as ratchets and peak load contribution |
| **Constraints** | Add ability to constrain solution based on budget, emissions, RE penetration |
| **Open source support** | Support user community development, review code submissions and accept/reject |
| **Gap analysis** | Analysis of the gap between model recommendations and implemented solutions. Interviews with ~10 partners to understand whether they implemented REopt recommendations, and why. |
| **REopt uncertainty analysis** | Research on how to address perfect forecasting, give users multiple options for results; result is implementable plan for REopt Lite, not actual implementation |
| **FTM battery value streams** | FTM Battery value stream research |
| **Maintenance** | Maintain servers, maintain URDB, update default assumptions, fix bugs |
| **User support** | Help desk (4 hours/week) |
| **Communications & outreach** | Website updates, case studies, news stories, 1-2 conferences. Press kit. Measure impact. Quarterly report. |

REopt Lite (tool and help manual): reopt.nrel.gov/tool

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

Send tool feedback and ask a question: reopt@nrel.gov

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www.nrel.gov

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