



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



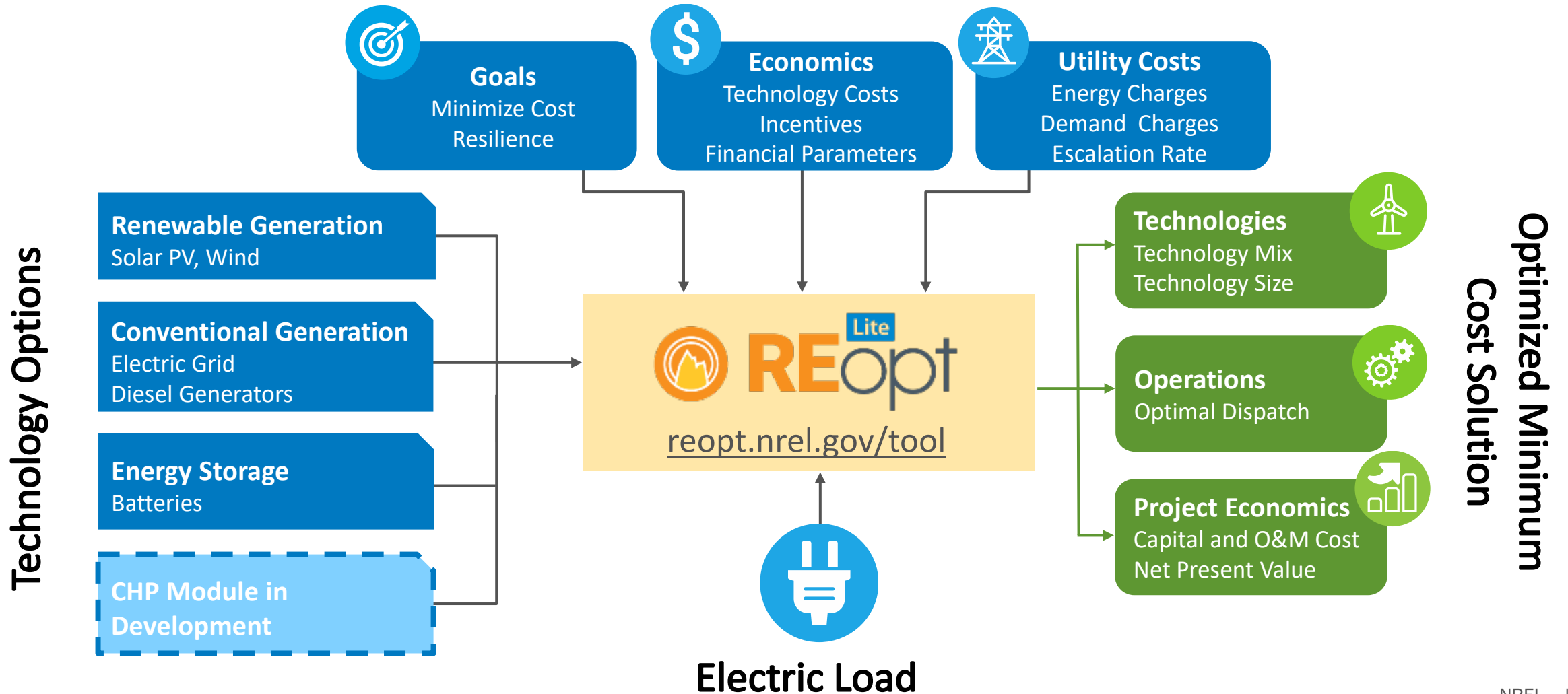
Financial
Parameters

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.

Drivers



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?



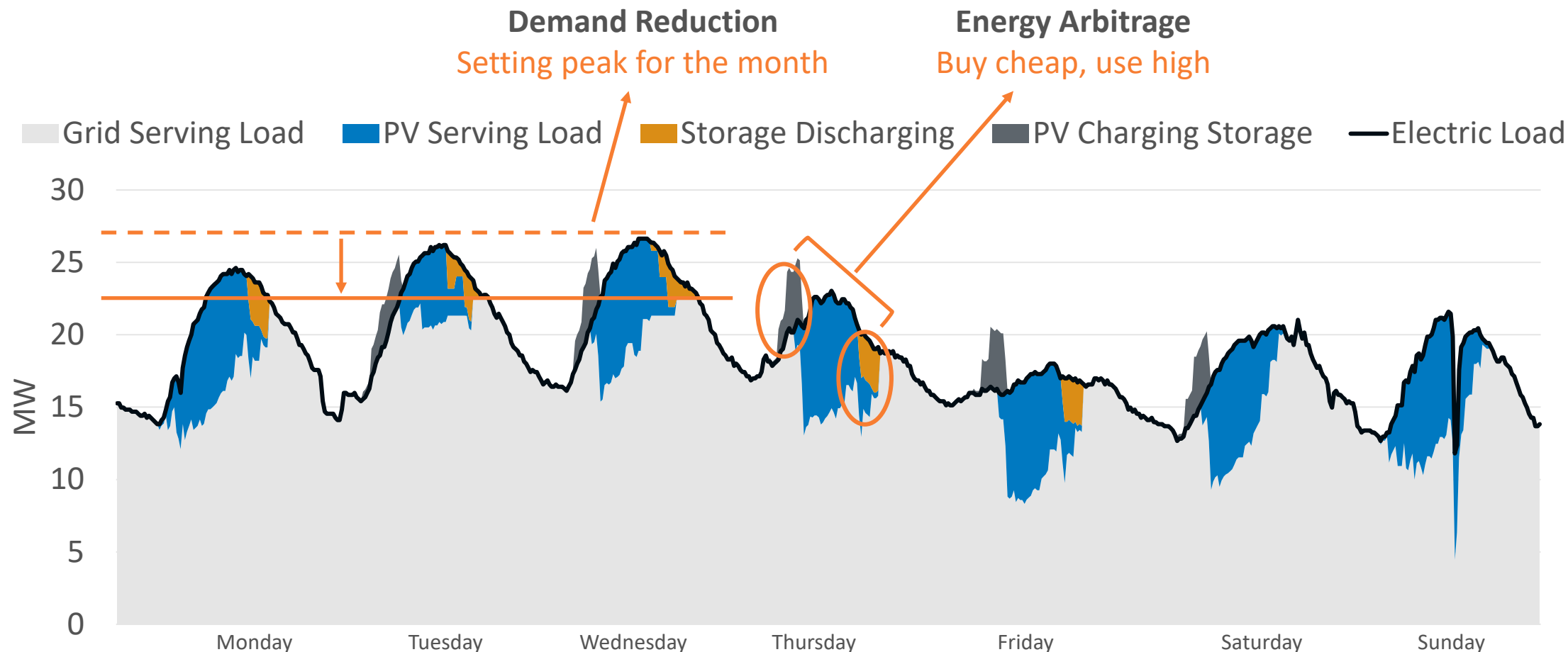
What will it cost to meet a sustainability or on-site generation goal?



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

How Does REopt Lite Work?

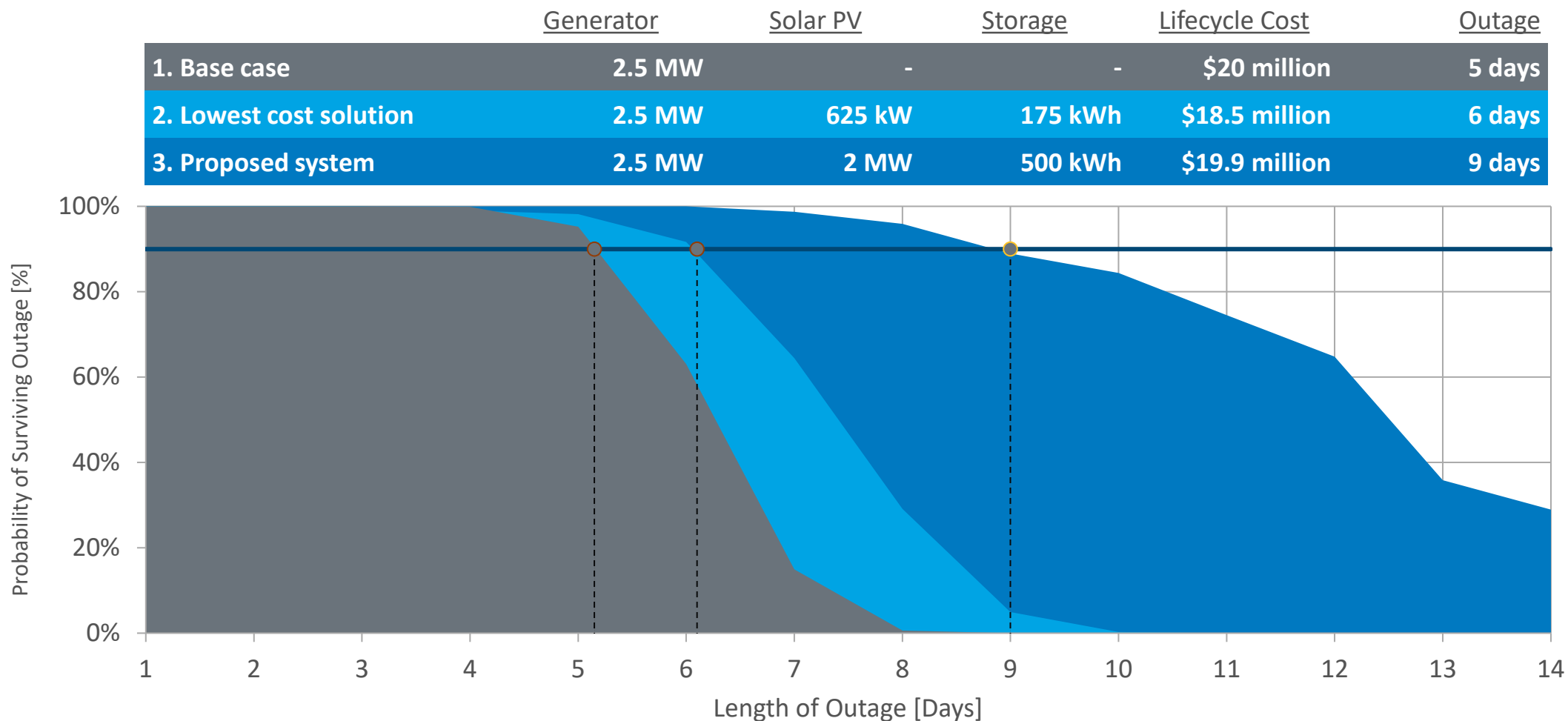
REopt Lite considers the trade-off between ownership costs and savings across multiple value streams to recommend optimal size and dispatch.



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.



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.

Step 1: Choose Your Focus

Do you want to optimize for financial savings or energy resilience?

\$ Financial

🛡️ Resilience



Step 2: Enter Your Site Data

Enter information about your site and adjust the default values as needed to see your results.

📍 Site and Utility (required)	+
📶 Load Profile (required)	+
\$ Financial	+

Step 3: Select Your Technologies

Which technologies do you wish to evaluate?

☒ PV ⚙️

☒ Battery 🔋

☐ Wind 🌬️

⚙️ PV	+
🔋 Battery	+

🔄 Reset to default values

Get Results ➡️

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.

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.



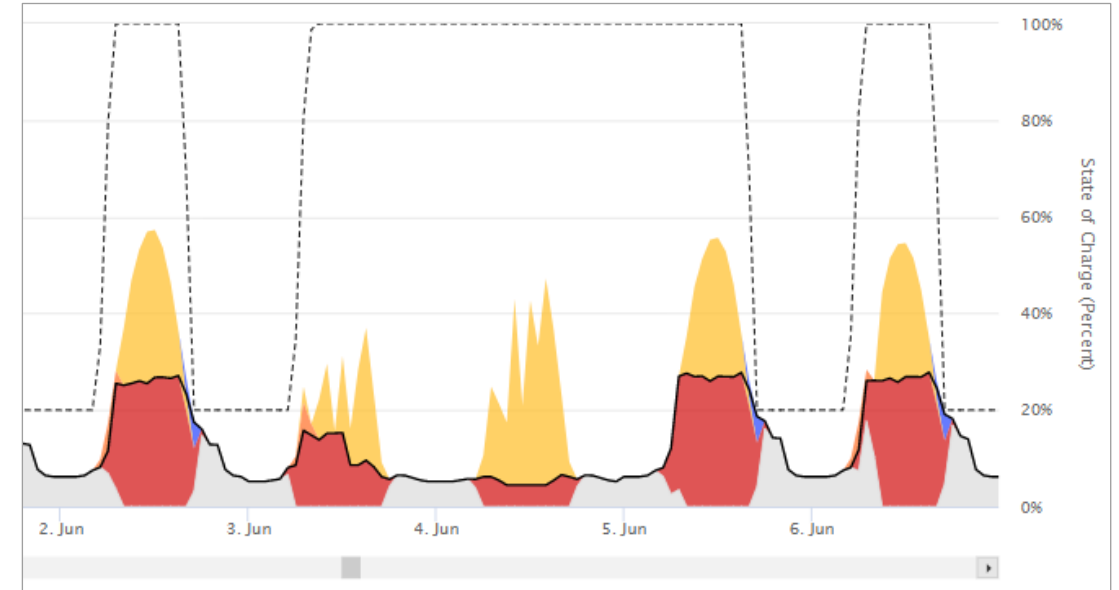
Your potential life cycle savings (20 years)



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)

Step 1: Choose Your Focus

Do you want to optimize for financial savings or energy resilience?

\$ Financial

🛡️ Resilience

Step 2: Enter Your Site Data

Enter information about your site and adjust the default values as needed to see your results.

📍 Site and Utility (required)

* Site location ?

Enter a location

* Electricity rate ?

▼

☐ Use custom electricity rate ?

Net metering system size limit (kW) ?

0

Wholesale rate (\$/kWh) ?

0

Site name ?

+ Advanced inputs

↺ Reset to default values

* Required field

[🌐 Use sample site](#)

} Location and utility rate

Required Site Specific Inputs (Financial Mode)

Step 1: Choose Your Focus



Do you want to optimize for financial savings or energy resilience?

\$ Financial


🛡️ Resilience

Step 2: Enter Your Site Data



Enter information about your site and adjust the default values as needed to see your results.


 **Load Profile** (required) 

* Required field


* **Typical load** 

How would you like to enter the typical energy load profile?

 Simulate  Upload

* **Type of building** 

Building Details

* **Annual energy consumption (kWh)** 

[Download typical load profile](#) [Chart typical load data](#)

Load profile –
simulated or actual

NREL | 14

Required Site Specific Inputs (Financial Mode)

Step 1: Choose Your Focus

Do you want to optimize for financial savings or energy resilience?

☒ Financial

☐ Resilience

Step 2: Enter Your Site Data

Enter information about your site and adjust the default values as needed to see your results.

Step 3: Select Your Technologies

Which technologies do you wish to evaluate?

☒ PV ⚙️

☒ Battery 🔋

☒ Wind 🌪️



Technologies to
evaluate



PV



Battery



Wind (Beta Version)



Additional Inputs Can Be Edited Or Left As Defaults

\$ Financial

Host discount rate, nominal (%) ?

8.3%

Electricity cost escalation rate, nominal (%) ?

2.3%

+ Advanced inputs

Reset to default values

\$ Financial

Host discount rate, nominal (%) ?

8.3%

Electricity cost escalation rate, nominal (%) ?

2.3%

Show fewer inputs

Analysis period (years) ?

25

Host effective tax rate (%) ?

26%

O&M cost escalation rate (%) ?

2.5%

Reset to default values

Key Results Output: System Sizes and Savings



Your recommended solar installation size



361 kW
PV size

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

This optimized size may not be commercially available. The user is responsible for finding a commercial product that is closest in size to this optimized size.



Your recommended battery power and capacity



78 kW
battery power

253 kWh
battery capacity

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

This optimized size may not be commercially available. The user is responsible for finding a commercial product that is closest in size to this optimized size.

Optimal system sizes are outputs of the tool.

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



Your potential life cycle savings (25 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.

\$209,418

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](#)

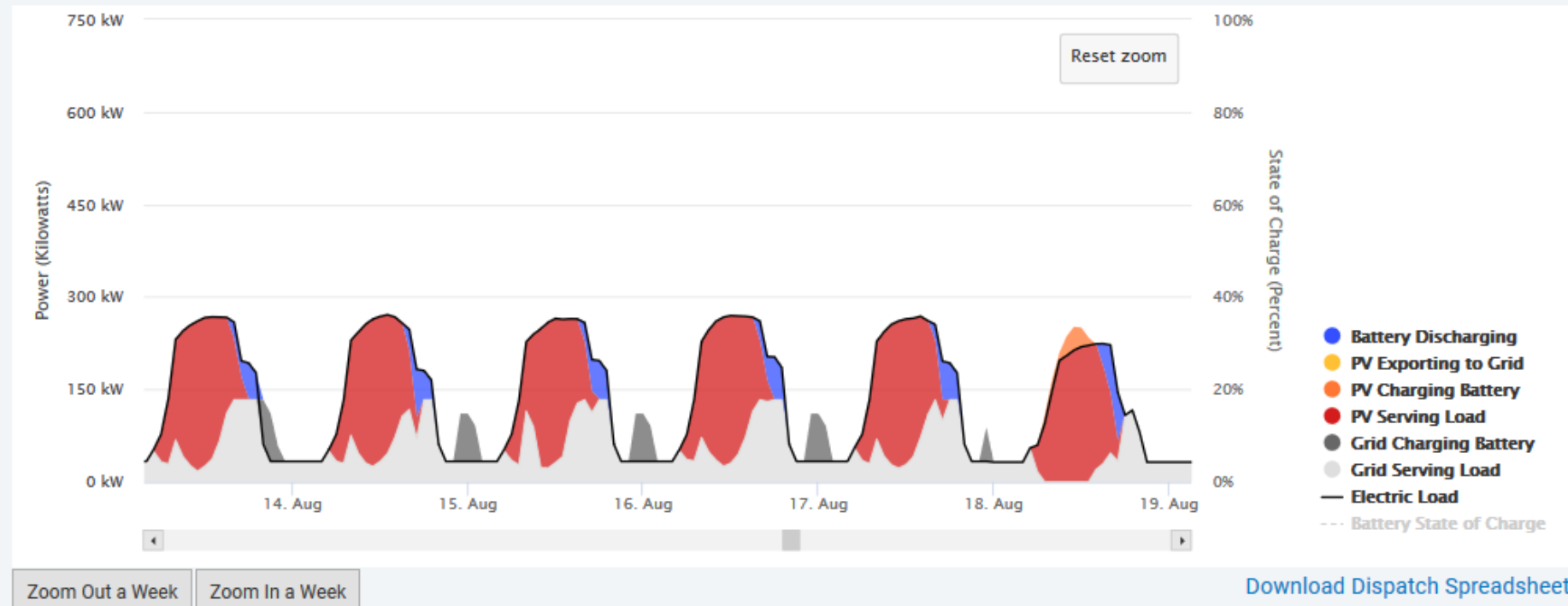
Compare the business as usual case with the optimal results from REopt Lite.

Download pro forma for more detailed financial results.

Additional Results Output: Hourly Dispatch Graph

System Performance Year One ?

This interactive graph shows the dispatch strategy optimized by REopt Lite for the specified outage period as well as the rest of the year. To zoom in on a date range, click and drag right in the chart area or use the "Zoom In a Week" button. To zoom out, click and drag left or use the "Zoom Out a Week" button.



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

Step 1: Choose Your Focus

Do you want to optimize for financial savings or energy resilience?

\$ Financial

🛡️ Resilience

🛡️ Resilience (required)

* Critical load ?
How would you like to enter the critical energy load profile?

% Percent

📁 Upload

🏗️ Build

Critical load factor (%) ?

50

📄 Download critical load profile

📊 Chart critical load data

* Outage information

* Outage duration (hours) ?

* Outage start date ?

📅

Autoselect using critical load profile ?

* Outage start time ?

▼

Type of outage event ?

Major Outage - Occurs once per project lifetime

▼

🔄 Reset to default values

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



Step 3: Select Your Technologies



Which technologies do you wish to evaluate?

☒ PV  ☒ Battery  ☐ Wind  ☒ Generator 

Generator option for resilience evaluation

 PV 

 Battery 

 Generator 

Install cost (\$/kW) ?

Diesel cost (\$/gal) ?

Fuel availability (gallons) ?

☒ Existing diesel generator?

* Existing diesel generator size (kW) ?

[+ Advanced inputs](#) [Reset to default values](#)

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.

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



[System survives specified 168-hour outage](#)

72%

[System survives 72% of 168-hour outages](#)

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

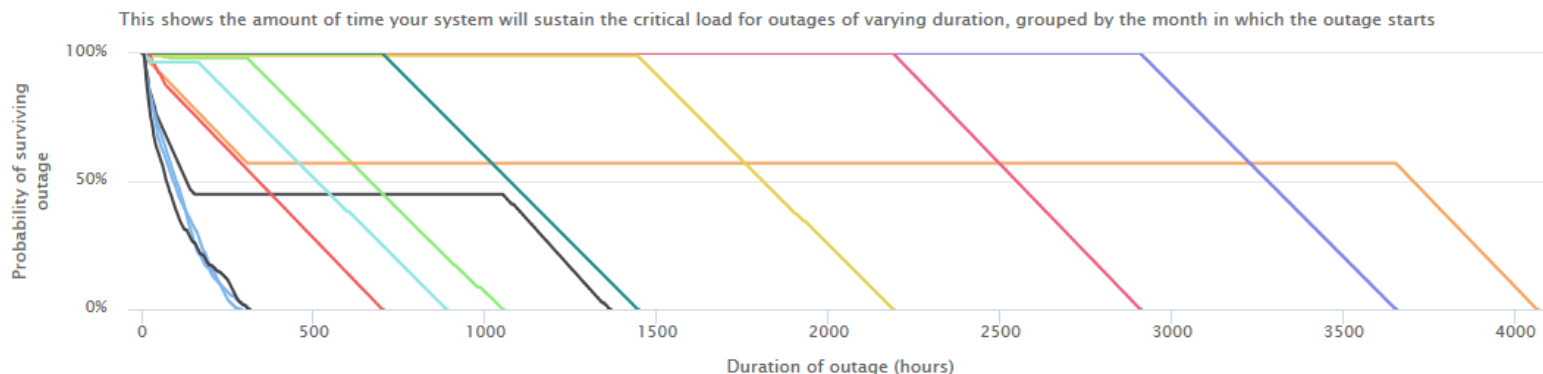
Outage Simulation

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

Yearly

Monthly

Hourly

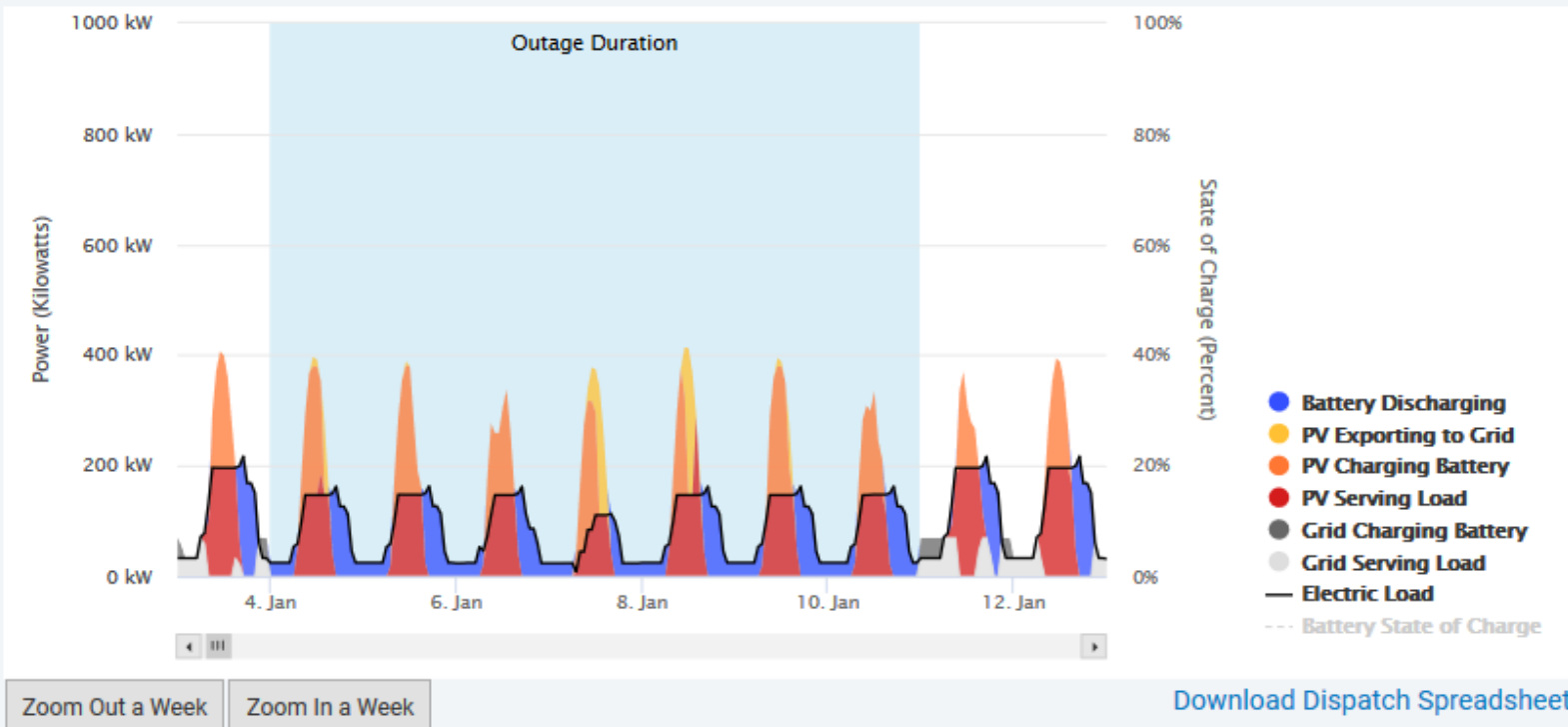


REopt Lite simulates outages of varying length throughout the year.

Resilience Output: Dispatch During Outage

System Performance Year One ?

This interactive graph shows the dispatch strategy optimized by REopt Lite for the specified outage period as well as the rest of the year. To zoom in on a date range, click and drag right in the chart area or use the "Zoom In a Week" button. To zoom out, click and drag left or use the "Zoom Out a Week" button.



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

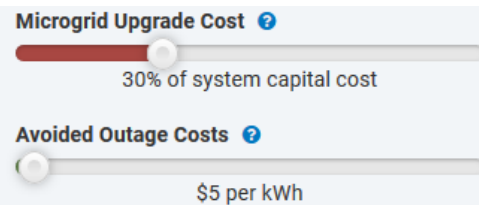
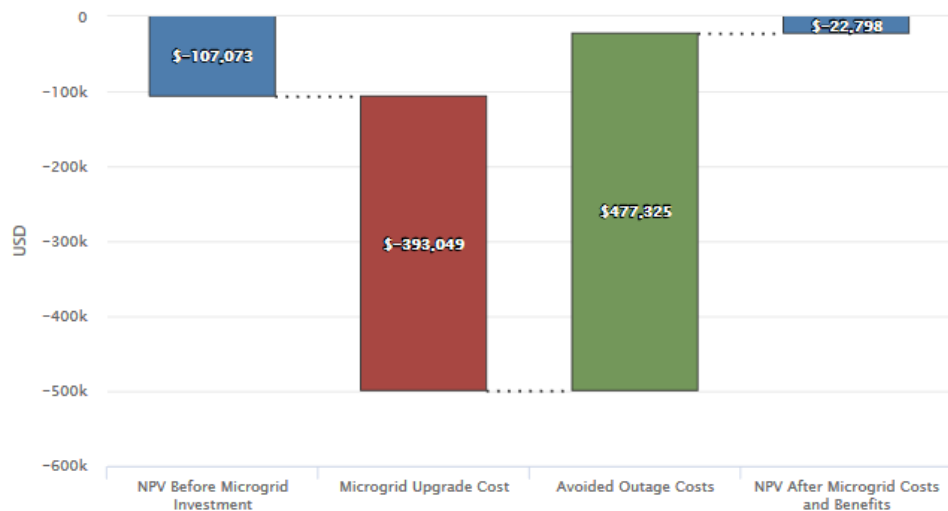
The load is met exclusively by the PV and storage that REopt Lite selected.

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 220 kW Battery 1,288 kWh Battery	361 kW PV 78 kW Battery 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.

Developer Network

[HOME](#)[DOCUMENTATION](#)[COMMUNITY](#)

[Documentation](#) » [Energy Optimization](#) » **REopt Lite™ API (Version 1)**

REopt Lite™ API (Version 1)

The REopt Lite™ API recommends an optimal mix of renewable energy savings and energy performance goals, including the hourly optimal mix. It provides an interface for interactively setting up input parameters.

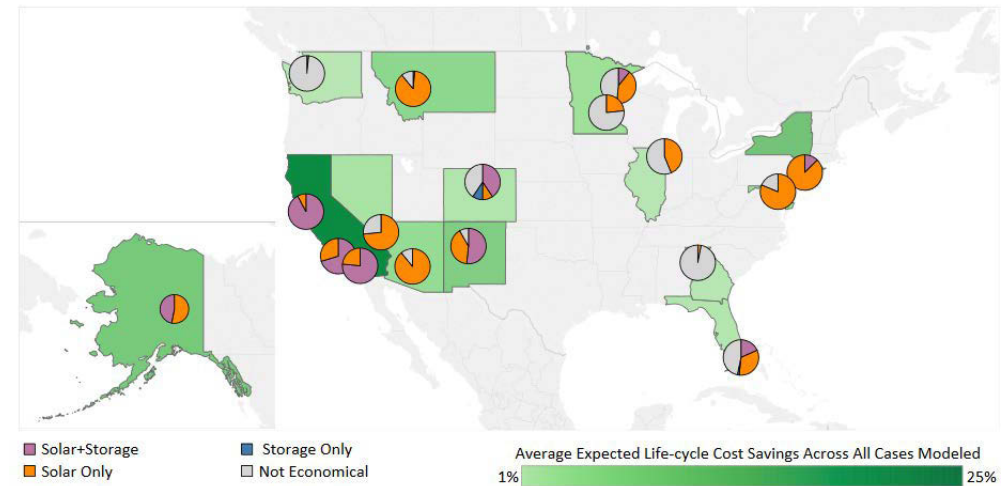
The API uses utility rates from the [Utility Rate Database](#) and solar PV profiles from the [Solar Resource Database](#), but is also equipped with simulated profiles for sites without real data.

- [Endpoints](#)
- [User Workflow](#)
- [Formatting and Posting a Job](#)
- [Getting Results](#)
- [Downloading a Proforma](#)
- [Getting Resilience Statistics](#)
- [Example Workflow](#)
- [Common Errors](#)

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

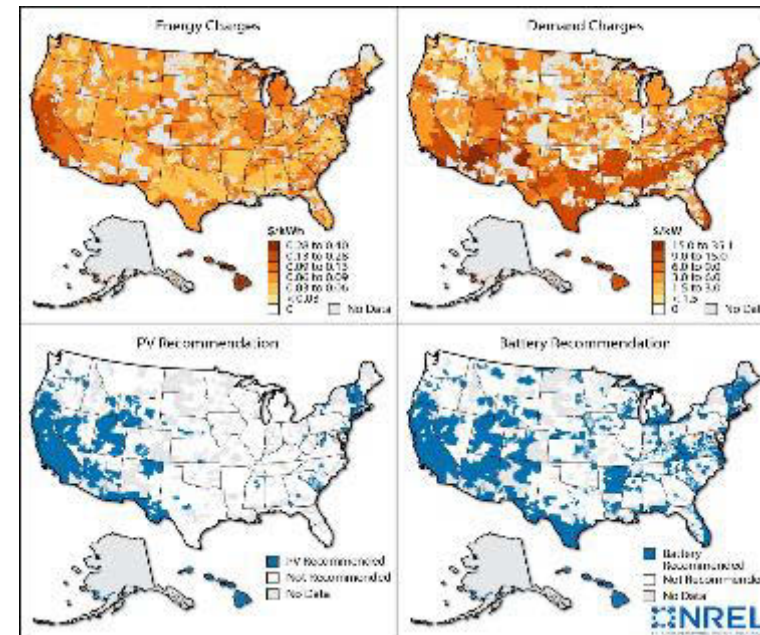
Analysis Enabled by API

- 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

www.nrel.gov

NREL/PR-7A40-76420

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