REopt: Renewable Energy Integration & Optimization

Link to Results Page

Results for Your Site

Your site at 1250 12th Street Golden CO USA evaluated on February 19, 2020

These results from REopt lite summarize the most cost-effective combination of PV, wind, battery storage and/or diesel generator designed to sustain a critical load at your site. You can edit your inputs to see how changes to your energy strategies affect the results.

Your recommended solar installation size

156 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

393 kW
battery power

57,941 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.

Your recommended generator size

0 kW
generator size

Measured in kilowatts (kW) of alternating current (AC), this recommended generator size minimizes the life cycle cost of energy at your site during a grid outage.

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 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.

-$22,651,860

Your Potential Resilience

This system sustains the 50% critical load during the specified outage period, from June 1 at 1 am to June 15 at 1 am.

This system sustains the critical load for 76% of all potential 336 hour outages throughout the year.

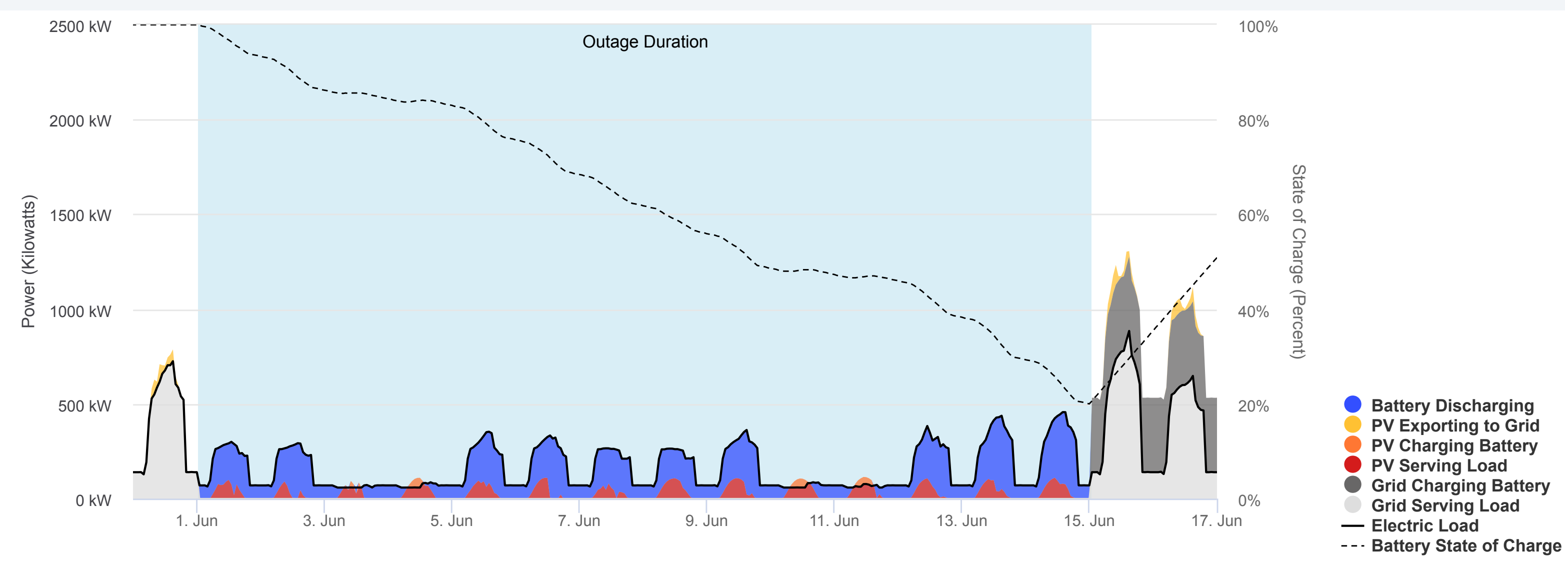
System survives specified 336-hour outage

76% System survives 76% of 336-hour outages

System Performance Year One

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.



$ Resilience vs. Financial

Resilience Benefits

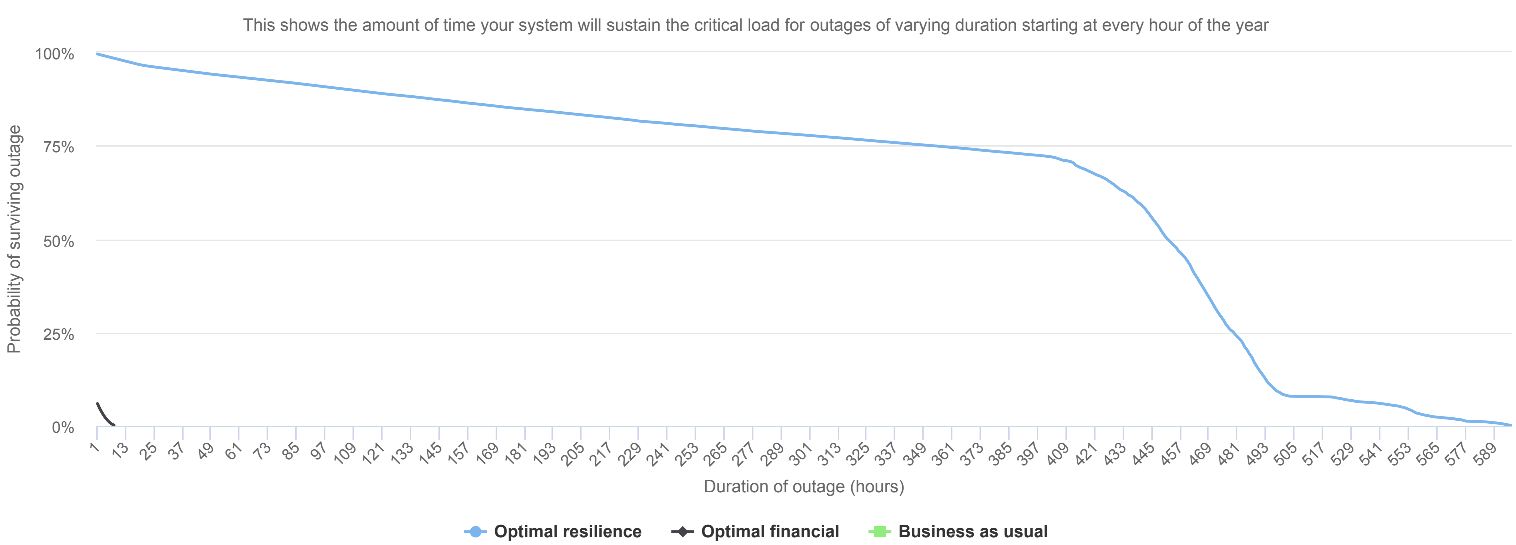
This system was designed to sustain the critical load during the outage period specified at lowest cost. The results below show how the system performs during outages occurring at other times of the year. Outages are simulated starting at every hour of the year and amount of time the system can sustain the critical load during each outage is calculated. The resilient system is compared to the business as usual system and a system designed for maximum financial benefits.

	Business As Usual	Resilience	Financial
System	None	0 kW Diesel 156 kW PV 393 kW Battery 57,941 kWh Battery	0 kW Diesel 156 kW PV 0 kW Battery 0 kWh Battery
NPV	$0	-$22,651,860	$59,197
Survives Specified Outage	No	Yes	No
Average	0 hrs	388 hrs	1 hrs
Minimum	0 hrs	0 hrs	0 hrs
Maximum	0 hrs	596 hrs	8 hrs
Diesel Generator Fuel Used	0 gal	0 gal	0 gal

Outage Simulation

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

Yearly



Results Comparison

Results Comparison

These results show how doing business as usual compares to the optimal case.

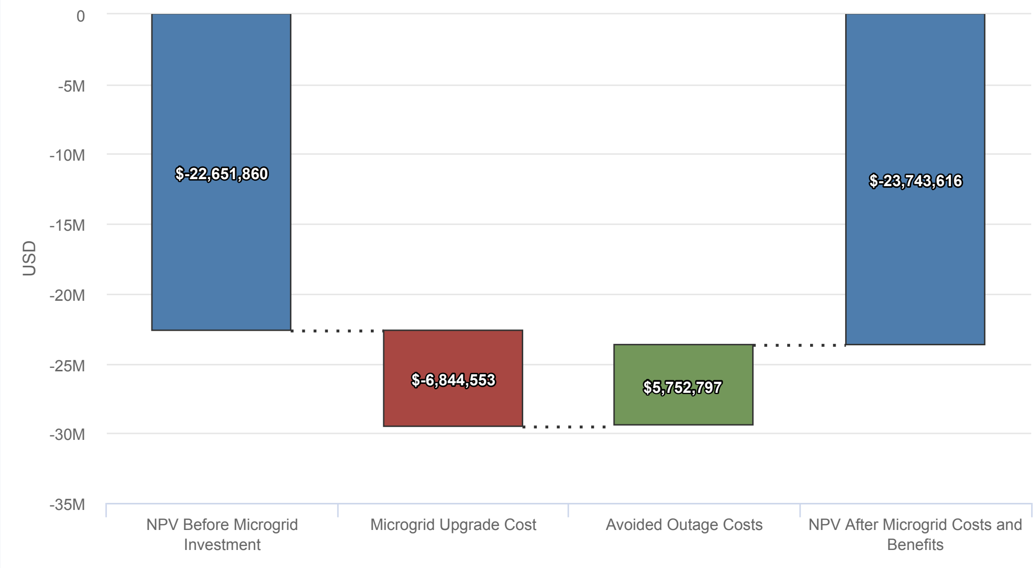
	Business As Usual	Resilience	Financial

System Size, Energy Production, and System Cost			
PV Size	0 kW	156 kW	156 kW
Annualized PV Energy Production	0 kWh	203,130 kWh	203,130 kWh
Battery Power	0 kW	393 kW	0 kW
Battery Capacity	0 kWh	57,941 kWh	0 kWh
Generator Size	0 kW	0 kW	0 kW
Net CAPEX + Replacement + O&M	$0	$22,834,976	$174,374
Energy Supplied From Grid in Year 1	2,491,474 kWh	2,526,997 kWh	2,600,000 kWh
Year 1 Utility Cost — Before Tax			
Utility Energy Cost	$281,761	$262,651	$270,907
Utility Demand Cost	$0	$0	$0
Utility Fixed Cost	$360	$360	$360
Utility Minimum Cost Adder	$0	$0	$0
Life Cycle Utility Cost — After Tax			
Utility Energy Cost	$2,699,879	$2,516,762	$2,595,872
Utility Demand Cost	$0	$0	$0
Utility Fixed Cost	$3,450	$3,450	$3,450
Utility Minimum Cost Adder	$0	$0	$0
Total System and Life Cycle Utility Cost — After Tax			
Total Life Cycle Costs	$2,703,328	$25,355,188	$2,761,735
Net Present Value	$0	-$22,651,860	$59,197

Effect of Resilience Costs & Benefits

Effect of Resilience Costs and Benefits

This interactive waterfall chart allows the user to consider the cumulative effect of extra costs and benefits of increased resilience on the project's net present value (NPV). Upgrading the recommended system to a microgrid allows a site to operate in both grid-connected and island-mode. This requires additional investment, which may include extra equipment such as controllers, distribution system infrastructure and communications upgrades. Economic benefit is observed when the value of avoiding the costs of an outage are considered. These microgrid upgrade costs and avoided outage costs are not factored into the optimization results. The sliders under the chart allow the user to change the Microgrid Upgrade Cost and the Avoided Outage Costs to analyze the impact on the NPV after Microgrid Costs and Benefits, while the NPV Before Microgrid Investment, which is determined by the optimization results, remains static.



Microgrid Upgrade Cost

30% of system capital cost

Avoided Outage Costs

$100 per kWh

Inputs

Your Inputs

The results are based on the following inputs.

Site and Utility	
Site name	Mines - PV and Battery
Site Location	1250 12th Street, Golden, CO, USA
Latitude	39.7531151
Longitude	-105.2274497
Land available (acres)	0.935
Roofspace available (sq ft)	0
Typical load profile type	simulated
Type of building	School - Secondary
Annual energy consumption (kWh)	2,600,000
URDB rate	Intermountain Rural Elec Assn - Commercial Service - Three Phase (E3)
Analysis focus	resilience
Analyze PV	yes
Analyze battery	yes

Analyze wind	no
Analyze generator during outage	yes

Financial	
Analysis period (years)	25
Host discount rate, nominal (%)	8.3%
Host effective tax rate (%)	26%
Electricity cost escalation rate, nominal (%)	2.3%
O&M cost escalation rate (%)	2.5%

PV	
System capital cost ($/kW)	1800.0
O&M cost ($/kW per year)	13.0
Minimum size desired (kW DC)	0
Maximum size desired (kW DC)	Unlimited
Module Type	Standard
Array Type	Rooftop, Fixed
Array azimuth (deg)	180
Array tilt (deg)	10
DC to AC size ratio	1.2
System losses (%)	14%
Net metering system size limit (kW)	25
Wholesale rate ($/kWh)	$0.12
Federal percentage-based incentive (%)	26%
Federal maximum incentive (%)	Unlimited
Federal rebate ($/kW)	$0
Federal maximum rebate ($)	Unlimited
State percentage-based incentive (%)	0%
State maximum incentive ($)	Unlimited
State rebate ($/kW)	$0
State maximum rebate ($)	Unlimited
Utility percentage-based incentive (%)	0%
Utility maximum incentive ($)	Unlimited
Utility rebate ($/kW)	$0
Utility maximum rebate ($)	Unlimited
Production incentive ($/kWh)	$0

Incentive duration (years)	1
Maximum incentive ($)	Unlimited
System size limit (kW)	Unlimited
MACRS bonus depreciation	100%
MACRS schedule	5 years
Existing PV systems size (kW)	N/A
Type of load profile	N/A

Battery	
Energy capacity cost ($/kWh)	$420
Power capacity cost ($/kW)	$840
Energy capacity replacement cost ($/kWh)	$200
Energy capacity replacement year	10
Power capacity replacement cost ($/kW)	$410
Power capacity replacement year	10
Minimum energy capacity (kWh)	0
Maximum energy capacity (kWh)	Unlimited
Minimum power capacity (kW)	0
Maximum power capacity (kW)	Unlimited
Rectifier efficiency (%)	96%
Round trip efficiency (%)	97.5%
Inverter efficiency (%)	96%
Minimum state of charge (%)	20%
Initial state of charge (%)	50%
Allow grid to charge battery	Yes
Total percentage-based incentive (%)	0%
Total rebate ($/kW)	$0
MACRS schedule	7 years
MACRS bonus depreciation	100%

Generator	
Existing diesel generator size (kW)	Existing Kw
Fuel availability (gallons)	660
Minimum new generator size (kW)	0
Maximum new generator size (kW)	0.0
Install cost ($/kW)	$500

Fixed O&M cost ($/kW per year)	$10
Variable O&M cost ($/kWh)	$0.00
Diesel cost ($/gal)	$3
Fuel burn rate (gallons/kWh)	Capacity-based default value
Fuel consumption curve y-intercept (gallons/hour)	Capacity-based default value

Resilience	
Outage Start Date	Jun 1
Outage start time	1 am
Outage duration (hours)	336
Type of outage event	Major Outage - Occurs once per project lifetime
Critical load profile type	Percent
Critical load factor	50%

Caution

Caution

These results assume perfect prediction of both solar irradiance, wind speed, and electrical load. In practice, actual savings may be lower based on the ability to accurately predict solar irradiance, wind speed, and load, and the battery control strategy used in the system. And, when modeling an outage the results assume perfect foresight of the impending outage, allowing the battery system to charge in the hours leading up the outage.

The results include both expected energy and demand savings. However, the hourly model does not capture inter-hour variability of the PV and wind resource. Because demand is typically determined based on the maximum 15-minute peak, the estimated savings from demand reduction may be exaggerated. The hourly simulation uses one year of load data and one year of solar and wind resource data. Actual demand charges and savings will vary from year to year as load and resource vary.

Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules.

Next Steps

Next Steps

This model provides an **estimate** of the techno-economic feasibility of solar, wind, and battery, but investment decisions should not be made based on these results alone. **Before moving ahead with project development, verify:**

- The utility rate tariff is correct.
    - Note that a site may have the option or may be required to switch to a different utility rate tariff when installing a PV, wind, or battery system.
    - Contact your utility for more information.
- Actual load data is used rather than a simulated load profile.
- PV, wind, and battery costs and incentives are accurate for your location.
    - There may be additional value streams not included in this analysis such as ancillary services or capacity payments.
- Financial inputs are accurate, especially discount rate and utility escalation rate.
- Other factors that can inform decision-making, but are not captured in this model, are considered. These may include:

    - roof integrity
    - shading considerations
    - obstacles to wind flow
    - ease of permitting
    - mission compatibility
    - regulatory and zoning ordinances
    - utility interconnection rules
    - availability of funding.
- Multiple systems integrators are consulted and multiple proposals are received. These will help to refine system architecture and projected costs and benefits. REopt results can be used to inform these discussions.

Contact NREL at reopt@nrel.gov for more detailed modeling and project development assistance.