Energy Exchange℠

ADVANCING FEDERAL INFRASTRUCTURE THROUGH INNOVATION

CINCINNATI, OHIO
OCTOBER 25-27, 2022

Techno-Economic Modeling of Resilient DER Using REopt

An Introduction to REopt's Resilience Modeling

Dan Olis

Senior Research Engineer

NREL

Presentation Overview

- Introduction to NREL's REopt Modeling Platform
- Resilience Analyses in REopt
- Example Scenario
- Coming Soon: New Reliability Assessment Capability

Intro to REopt Modeling Platform

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

- As costs decrease, renewable energy deployment is growing worldwide.
- Distributed energy technologies can provide cost savings, resilience, and emissions reduction.
- With increasingly integrated and complex systems, back-of-the-envelope calculations are no longer sufficient to determine distributed energy project potential.

REopt Optimizes Integrated Energy Systems

- NREL's REopt® platform optimizes planning of generation, storage, and controllable loads to maximize the value of integrated systems.
- REopt considers electrical, heating, and cooling loads and technologies simultaneously to identify the optimal technology or mix of technologies.
- REopt transforms complex decisions into actionable results for building owners, utilities, developers, and industry.
- REopt analysis guides investment in economic, resilient, sustainable energy technologies.

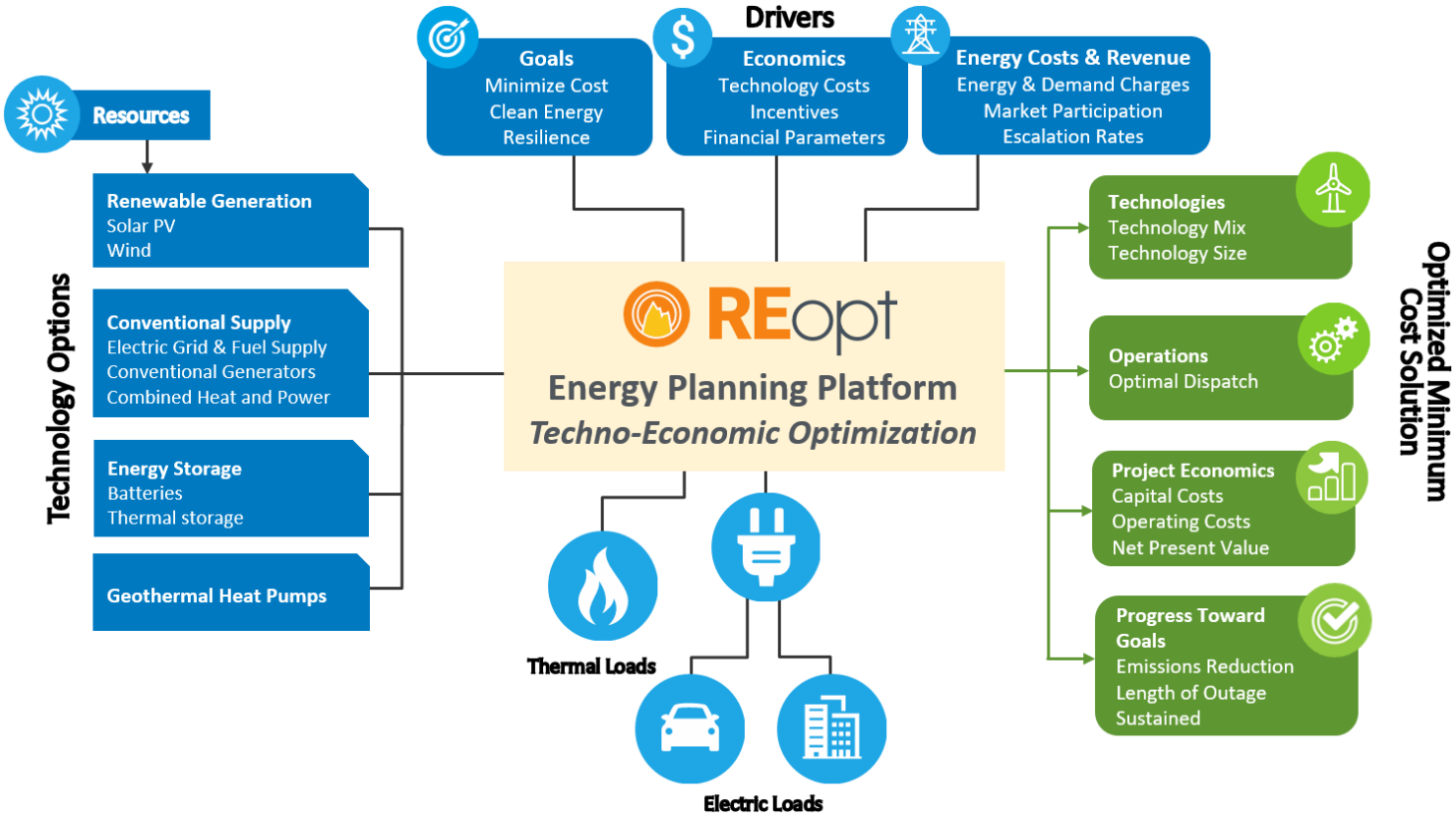
Will Distributed Energy Resources (DERs) Work for Your Site?

- Renewable Energy Resource
- Technology Costs and Incentives
- Site Goals
- Utility Cost and 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.

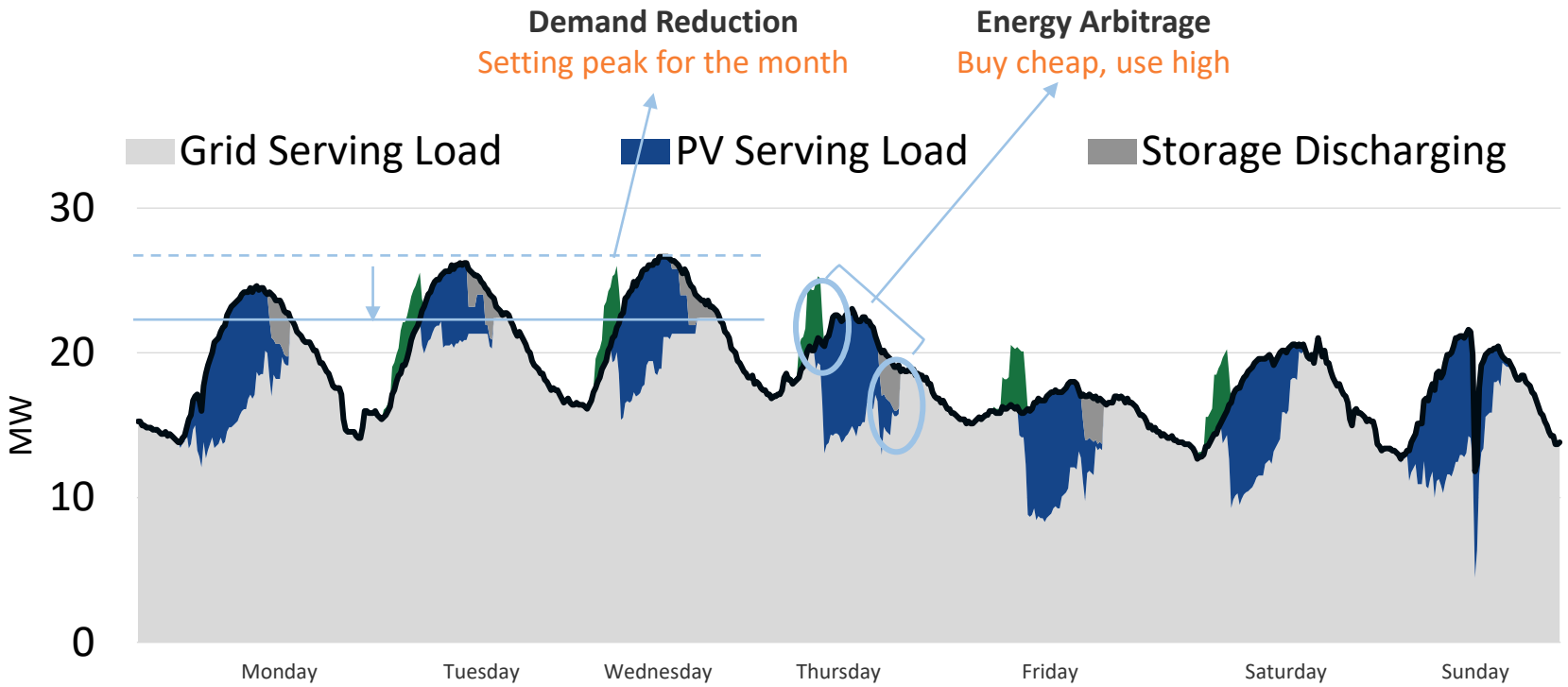
REopt Energy Planning Platform

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

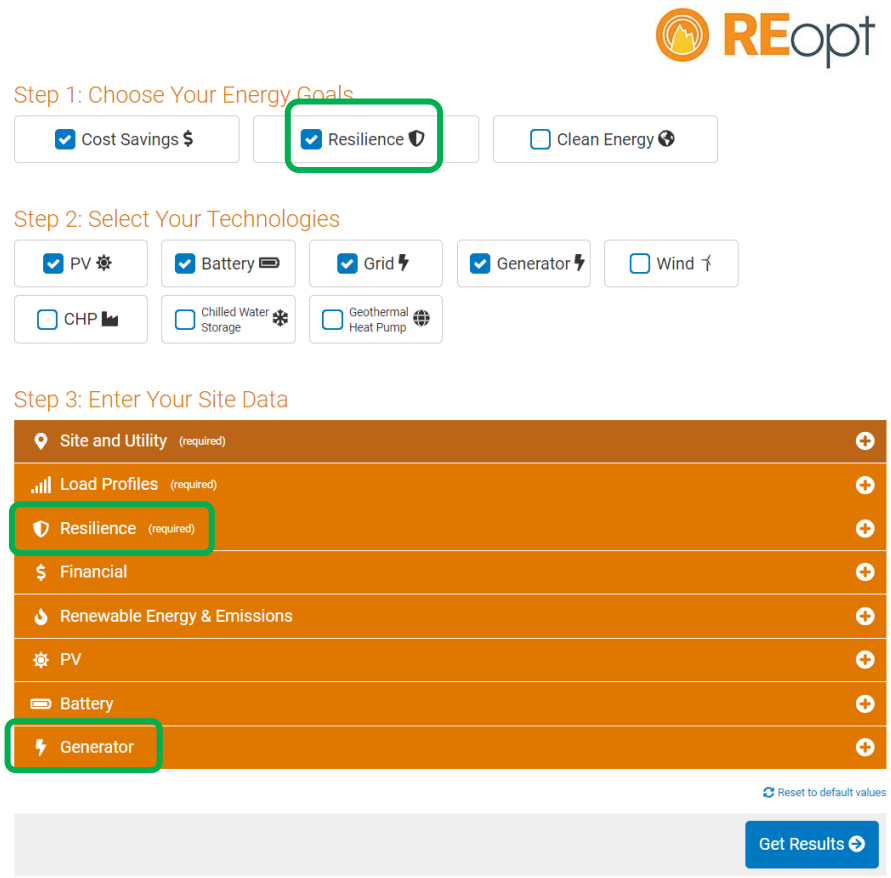


Example of optimal dispatch of PV and BESS

Resilience Analysis in REopt

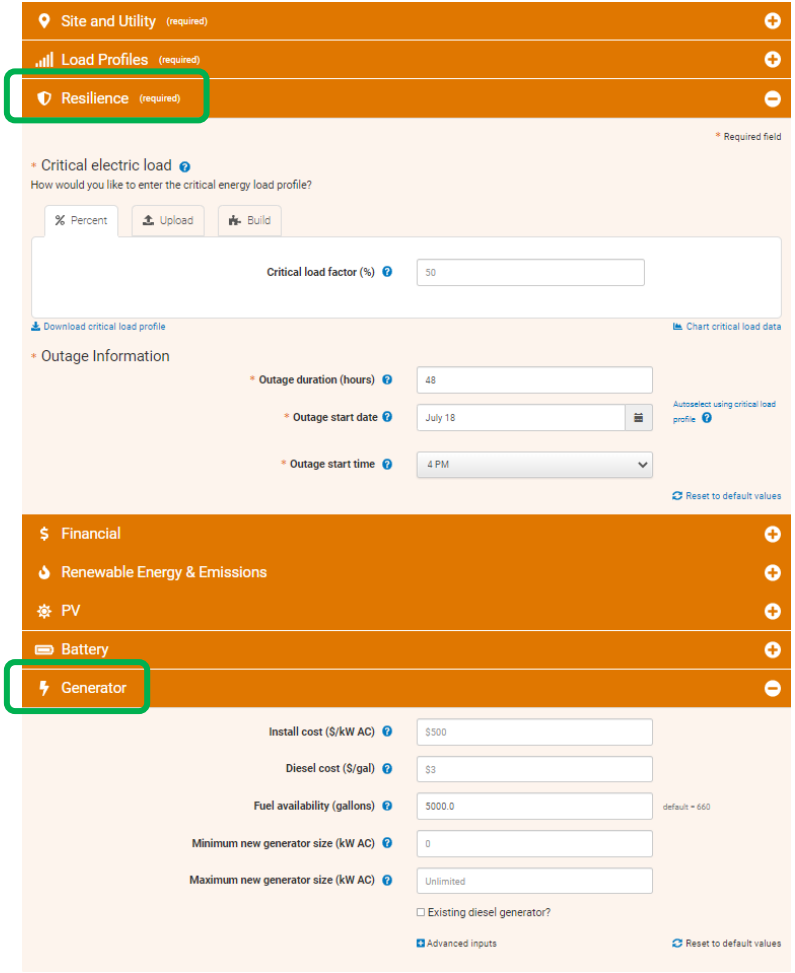
REopt Web Tool

- Free, publicly available, user-friendly
- Optimizes PV, wind, combined heat and power, geothermal heat pumps, and energy storage system sizes and dispatch
- Resilience mode optimizes these DER, along with backup generators, to sustain critical loads during grid outages
- Resilience mode uses the same objective as Cost Savings mode, to minimize life-cycle costs, but includes grid outage periods in determining the solution
- Access: reopt.nrel.gov/tool



Resilience Analysis

- Enter critical loads to be served during an outage
- Enter duration and expected worst case timing of outage of concern
- Emergency generator, if selected, is defined
- REopt identifies least-cost solution for life-cycle grid-tied economics *and* serving the critical load during a grid outage



Resilience Example

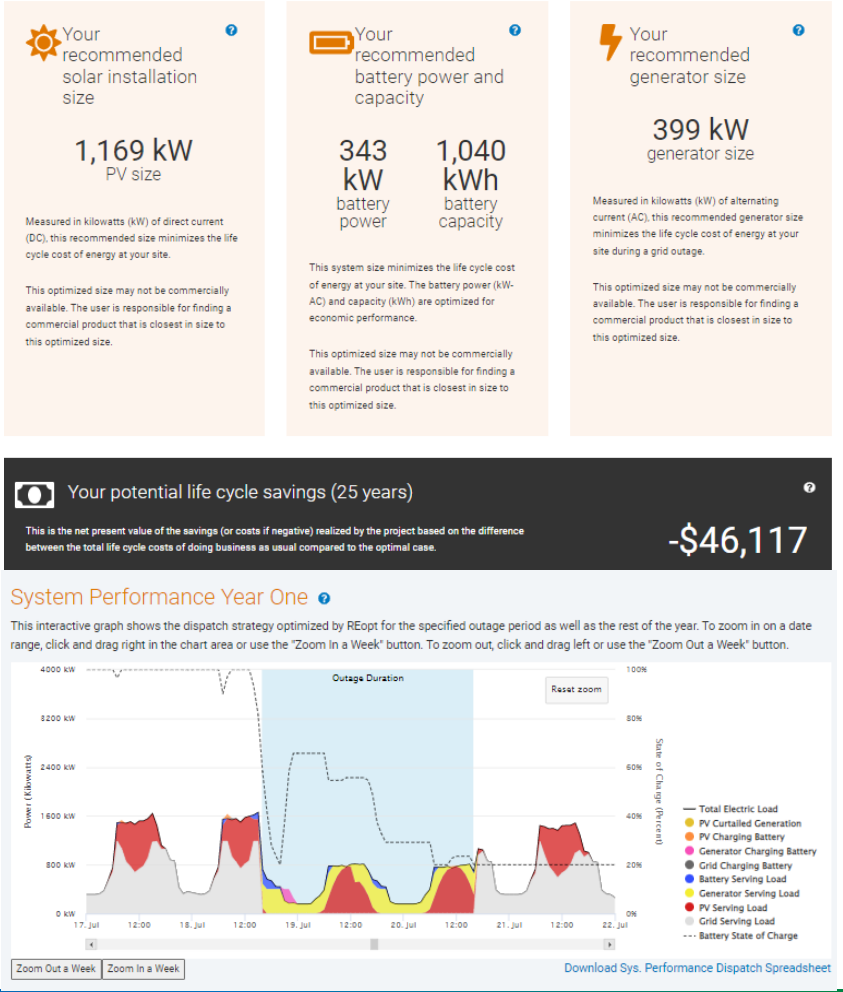
- Large Office in Denver, Colorado
  - Modeled using DOE Commercial Reference Building
- Xcel Secondary General Rate Tariff
- DER: PV, BESS, emergency diesel generator and unconstrained diesel fuel supply
- 48-hour outage starting at peak load (July 18)
- Critical load during outage is 50% of nominal load
- Costs and financial parameters are REopt defaults

Xcel CO Secondary General Tariff	
Energy $/kWh	$0.04764
G&T Demand ($/kW/month)	$19.02 M-F, Jun thru Sep $12.17 all other times
Distribution Demand ($/kW)	$6.98/month or 50% of highest in preceding 12 months

https://www.xcelenergy.com/staticfiles/xe-responsive/Company/Rates%20&%20Regulations/Electric-Summation-Sheet-All-Rates-07.01.22.pdf

Key Outputs

- System sizes and net present value
- Interactable and downloadable dispatch
- Detailed economics and resilience performance metrics



Key Outputs, cont.

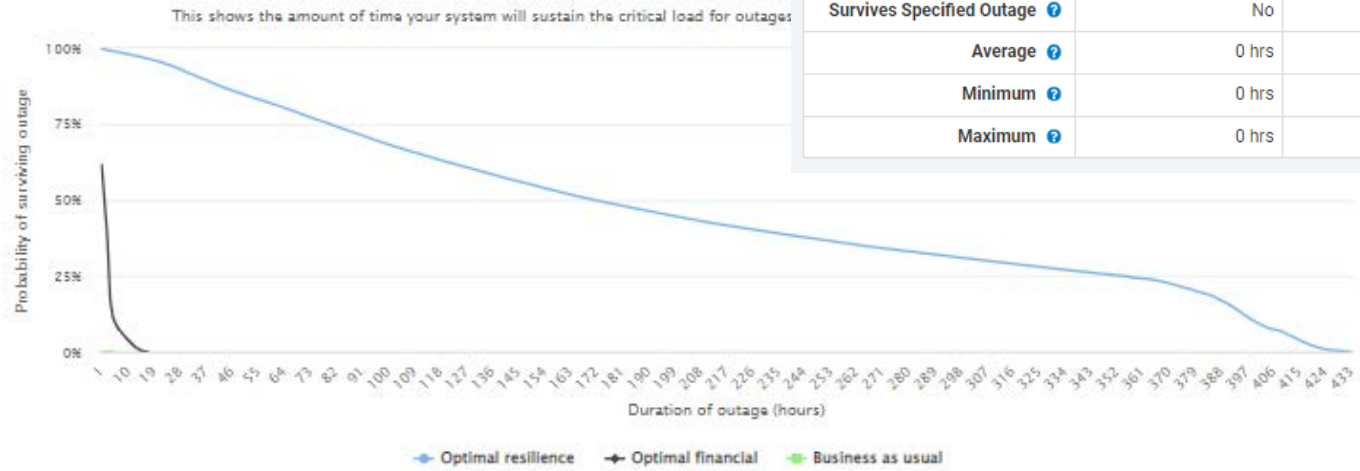
- Comparison of resilient solution to purely grid-tied economic solution
- Option to assess resilient solution against all other possible outages

	Business As Usual	Resilience	Financial
System	None	399 kW Diesel 1,169 kW PV 343 kW Battery 1,040 kWh Battery	0 kW Diesel 763 kW PV 263 kW Battery 600 kWh Battery
NPV	$0	-$46,117	$286,129
Diesel Generator Fuel Used	0 gal	919 gal	0 gal

Outage Simulation

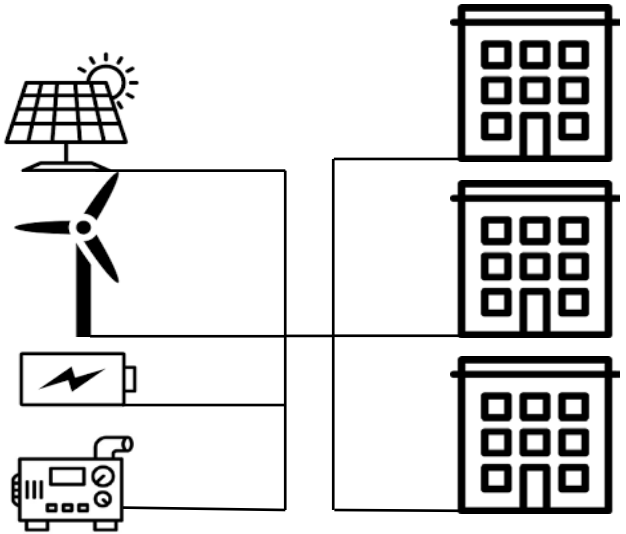
Evaluate the amount of time that your system can survive grid outages.

	Business As Usual	Resilience	Financial
System	None	399 kW Diesel 1,169 kW PV 343 kW Battery 1,040 kWh Battery	0 kW Diesel 763 kW PV 263 kW Battery 600 kWh Battery
Survives Specified Outage	No	Yes	No
Average	0 hrs	202 hrs	2 hrs
Minimum	0 hrs	0 hrs	0 hrs
Maximum	0 hrs	433 hrs	17 hrs



Adding Reliability Metrics This Year

- Optimization and current post-process performance assessment for all outages assumes all assets are 100% available and 100% reliable
- REopt will soon include an option to assess solution for reliability following the methods presented by Don Jenket in this session
- Default availability and mean-time-to-failure metrics will be provided based on field data and published reports for conventional and renewable generators and battery energy storage
- User-refined architectures to include number, size, N+x will be analyzed
- Funded by DOE Solar Energy Technologies Office and DoD Environmental Security Technology Certification Program



Marqusee, J., and Jenket, D. 2020. "Reliability of Emergency and Standby Diesel Generators: Impact on Energy Resiliency Solutions." *Applied Energy* 268: 114918

Thank you!

Dan Olis, NREL

dan.olis@nrel.gov

NREL/PR-7A40-84321

This work was authored by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Federal Energy Management Program. The views expressed 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 work 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.