#### $\bigcirc$ Energy Exchange 1 Î • á já \$ • # ĥ **ADVANCING FEDERAL INFRASTRUCTURE** CINCINNATI, OHIO THROUGH INNOVATION **OCTOBER 25-27, 2022**

# Techno-Economic Modeling of Resilient DER Using REopt

An Introduction to REopt's Resilience Modeling



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## **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<sup>®</sup> 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.

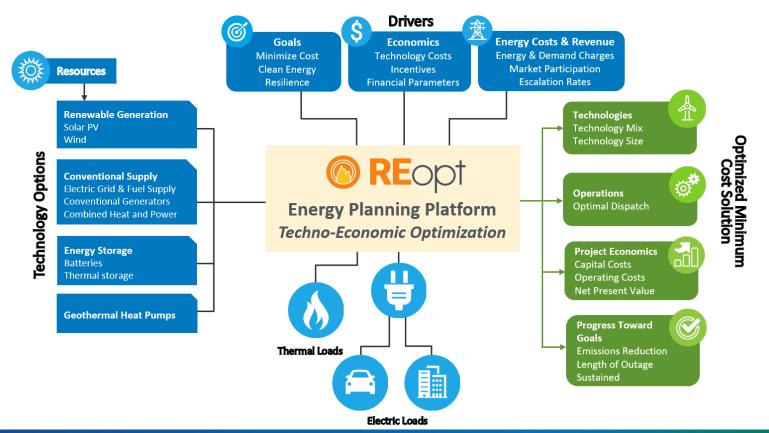
# Will Distributed Energy Resources (DERs) Work for Your Site?



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

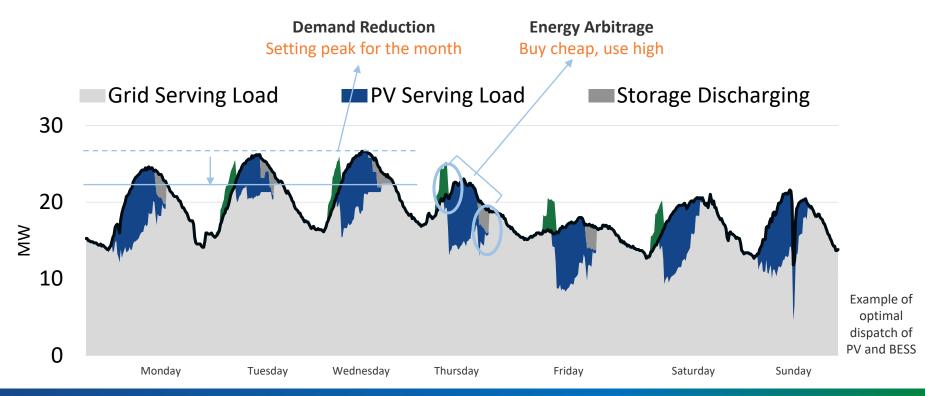
# **REopt Energy Planning Platform**

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.





# **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 lifecycle costs, but includes grid outage periods in determining the solution
- Access: <u>reopt.nrel.gov/tool</u>



#### Step 2: Select Your Technologies



#### Step 3: Enter Your Site Data



# **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

Site and Utility (required)		•
.III Load Profiles (required)		Ð
Resilience (required)		Θ
Critical electric load How would you like to enter the critical energy load profile? X Percent Lupload He Build		* Required field
Critical load factor (%) 💡	50	
A Download critical load profile		🖿 Chart critical load data
Outage Information Outage duration (hours)	48	Autoselect using critical load
* Outage start date 😧	July 18	profile 🕜
* Outage start time 💡	4 PM 🗸	
		2 Reset to default values
\$ Financial		Ð
Renewable Energy & Emissions		Ð
秦 PV		÷
Battery		€
🕈 Generator		e
Install cost (\$/kW AC) 💡	\$500	
Diesel cost (\$/gal) 💡	\$3	
Fuel availability (gallons) 💡	5000.0	default = 660
Minimum new generator size (kW AC) 💡	0	
Maximum new generator size (kW AC) 💡	Unlimited	
	Existing diesel generator?	
	Advanced inputs	C Reset to default values

# **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

Your recommended solar installation size	Your recommended battery power and capacity	Your recommended generator size
<section-header>      H, H, B, B, K, W, D' Size       Messured in kilowatts (kW) of direct current (bC), this recommended ise 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.</section-header>	343 battery power1,040 battery battery batteryThis system size minimizes the life cycle cost of energy at your site. The battery power (WA C) and capacity (WM) are optimized for economic performance.This optimized size may not be commercially aromercial product that is closest in size to this optimized size.	<b>399 KW</b> 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.
This is the net present value of the savings (or costs if between the total life cycle costs of doing business as System Performance Year	negative) realized by the project based on the difference usual compared to the optimal case.	-\$46,117

This interactive graph shows the dispatch strategy optimized by REopt 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.



# Key Outputs, cont.

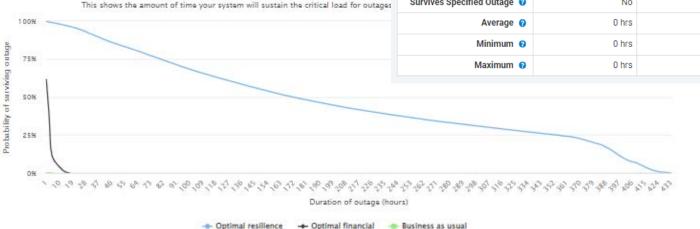
- Comparison of resilient solution to purely grid-tied economic solution
- Option to assess resilient solution against all other possible outages

	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

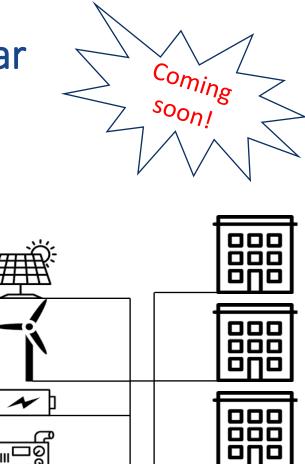
Evaluate the amount of time that your system can survive grid outages

		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
ges	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

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